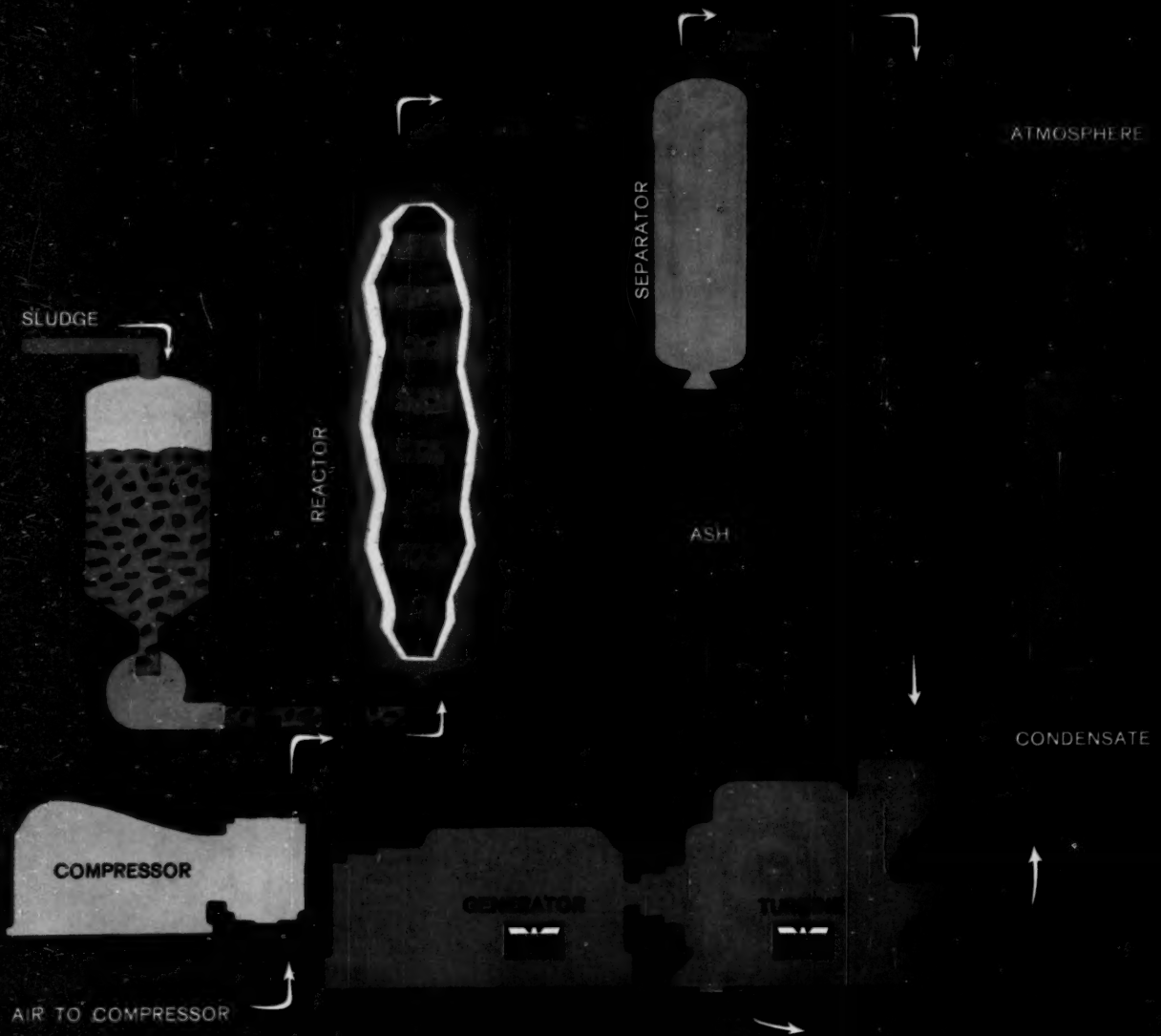
MAY 15, 1961
Published every-other-Monday
Seventy-five cents

Chemical Engineering

A McGRAW-HILL PUBLICATION

maximizing
profits
in
the
process
industries
by...

SOUND APPRAISALS OF CAPITAL INVESTMENTS



Worthington turbine generator and Zimmermann process produce...

FREE POWER FROM WASTE

Take nearly any combustible organic waste in aqueous solution. Then react it with air under high pressure. Then use the resulting gas and steam mixture to drive a Worthington power recovery turbine. With sufficient organic content you'll get enough power to run the disposal process—and in some instances a great deal more, too.

In Chicago a $12 million plant built on this Zimmermann Process* will dispose of 200 tons a day (dry basis) of sewage sludge. But the process runs equally well on many industrial organic wastes; for example, waste pulp liquor from a pulp mill and on much smaller tonnage than the large Chicago installation.

Key factor in process efficiency is the direct power recovery from gas-steam mixture produced by the reaction. In the Chicago installation, this mixture will drive a Worthington 12,500 kw. turbine generator.

Why was the Worthington turbine generator unit chosen? Because Worthington turbine specialists lead in designing turbines for power recovery from any gas mixture, including the gas-steam produced here. Because a Worthington generator has quality not exceeded by any other generator manufacturer today. And because of Worthington's reputation for extreme reliability in the industrial turbine field.

For further information about any power recovery turbine application, write or call Worthington Corporation, Turbine Division, Dept. 48-13, Wellsville, New York.

*The Zimmermann Process is patented and licensed by Sterling Drug Inc., N. Y. C., N. Y.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

The new, Appleton "CES-CESD" type receptacle Unilet and matching plug is feature-packed to give you outstanding performance for all industrial equipment requiring heavy-duty circuit breaking outlets *without* disconnect switches ahead of the outlet.

You will particularly like the installation simplicity—the push-pull operating ease and these Appleton convenience features . . .

Advanced, compact design • Interchangeability of plug or receptacle with certain other brands • pressure-type solderless receptacle connectors • exclusive plug-locking slide mechanism • smooth surfaces, chamfered edges • concealed cable clamp • choice of 30-ampere, ¾" hub or 60-ampere. 1¼" hub in CES or CESD types • and the quality construction that meets most installation requirements; CES for Class 1, Groups C and D—CESD for Class 1, Group D.

Wherever hazardous area installations *or replacements* are made, you can depend upon this latest Appleton development to give you safe, foolproof protection. Write today for full details—bulletin No. CES 660.

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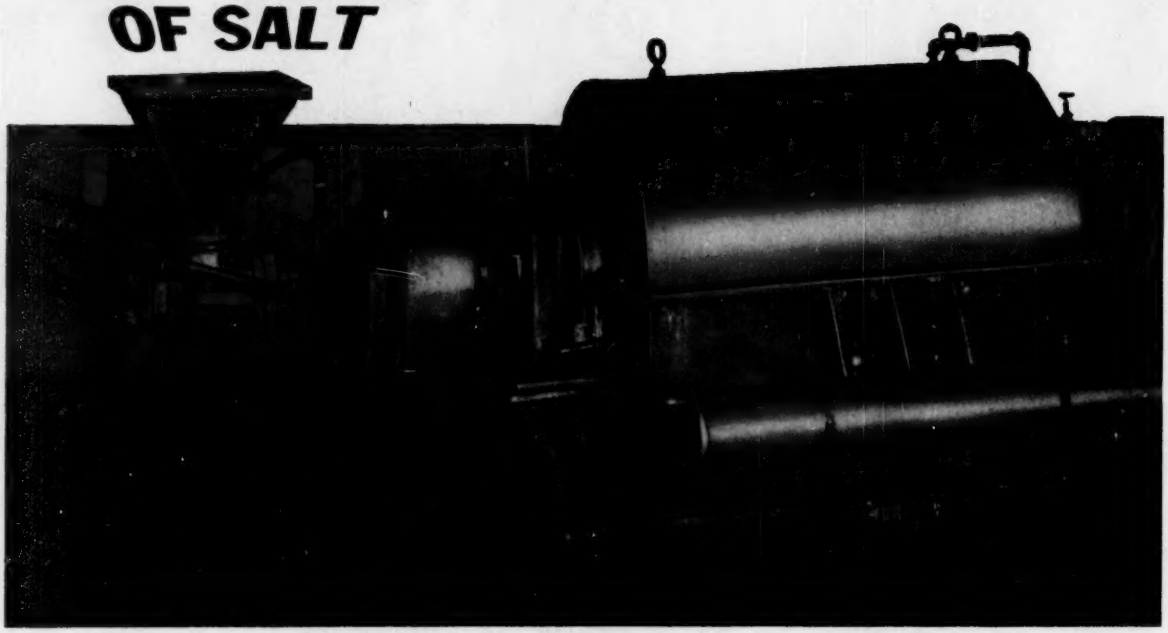

Are now separated from Caustic Solution in **Bird Continuous Centrifugals** like this

What this means to you

Salt from caustic is a comparatively easy filtering job. They used to think any old filter would do. Now, the bulk of this huge tonnage is put through Bird Centrifugals.

For example, the last three big electrolytic caustic plants built are all equipped one hundred per cent with Bird Continuous Centrifugals to handle both the strong and weak caustic solutions. Birds were installed only after careful and comprehensive comparison with all kinds of solid-liquid separating methods and equipment.

Whether *your* slurry is free filtering or slow, thick or thin, hot or cold, find out what the Bird Continuous Centrifugal can do in terms of solids dryness, filtrate clarity, output per hour and cost per ton. The Bird Research and Development Center can provide the answers via pilot-scale tests, promptly, accurately and in confidence.

This Bird delivers 3 tons of salt per hour — runs continuously 24 hours a day, 7 days a week. It has been on the job for twenty-two years.

BIRD MACHINE COMPANY
SOUTH WALPOLE, MASSACHUSETTS

BUILDERS OF THE COMPLETE LINE OF SOLID-LIQUID SEPARATING EQUIPMENT

Operators of the **Bird Research and Development Center** for pilot-scale testing to determine the correct equipment for the job. Yours to use.

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Chemical Engineering

May 15, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

PRINT ORDER FOR THIS ISSUE 53,170

WHAT'S HAPPENING

ENGINEERING PRACTICE

OTHER REGULAR FEATURES

VOLUME 68, NUMBER 10

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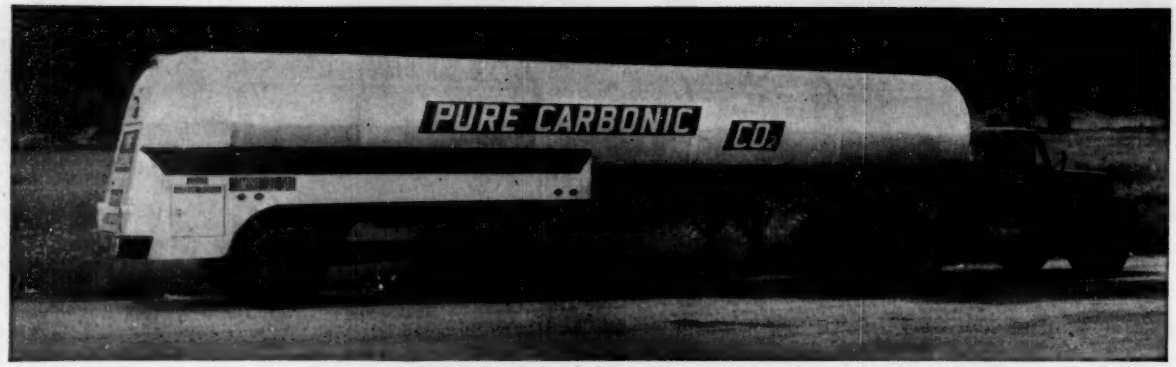


Hackney insulated transports for controlled or constant temperature applications. Engineered to deliver more miles of service per dollar invested. Built to your specifications, of T-1 steel, or various other steels, alloys, or stainless steels.

Highway, in-plant or high seas

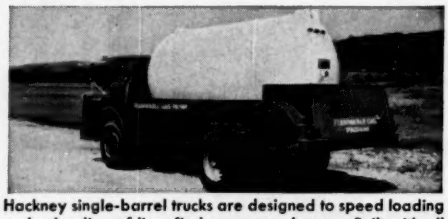
For profitable hauling, Hackney transportation equipment pays off

Wherever a compressed or liquefied gas requires a pressurized transportation vessel, you will find Hackney equipment doing the job—on the highways, within plants or on the high seas. And doing it at a profit to the user!

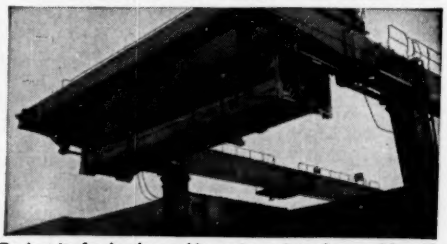
Every Hackney unit is engineered to meet service requirements, including complete piping, metering and transfer equipment...and temperature controls such as jackets, insulation, heating and refrigeration systems. Compliance with all regulations and highway laws is assured. Our facilities provide the latest equipment and engineering know-how for working all types of ferrous and nonferrous metals, as well as installing insulation, including popular "foamed-in-place" urethane.

Choose from our line of standard equipment or have our engineers design custom units for your special and unique applications. In either case, the Hackney trade-mark on your units is your assurance of complete attention to detail and consistent top quality. Call our representative today or write us direct for details.

Wagons for in-plant movements can be designed for any specific service.



Hackney single-barrel trucks are designed to speed loading and unloading of liquefied compressed gases. Built with all latest safety features and to comply with ICC specifications.



Tank units for land-sea shipment are interchangeable with dry freight containers.

Hackney single- or multi-compartment, noninsulated transports handle liquefied compressed gases such as refrigerants, LP-gas, ammonia, etc.

Pressed Steel Tank Company

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Chemical Engineering
MAY 15, 1961

highlights of this issue

HOW TO APPRAISE CAPITAL INVESTMENTS

Sizing up the profit potential of a new venture is not easy, as evidenced by the number of projects that fail to yield predicted earnings. John Hackney's Feature Report on capital venture control (p. 145) should help raise the CPI batting average. The author, well-known to many *CE* readers, is vice president of Pan-American Management Ltd.

DESIGNING TEMPERATURE-STABLE REACTORS

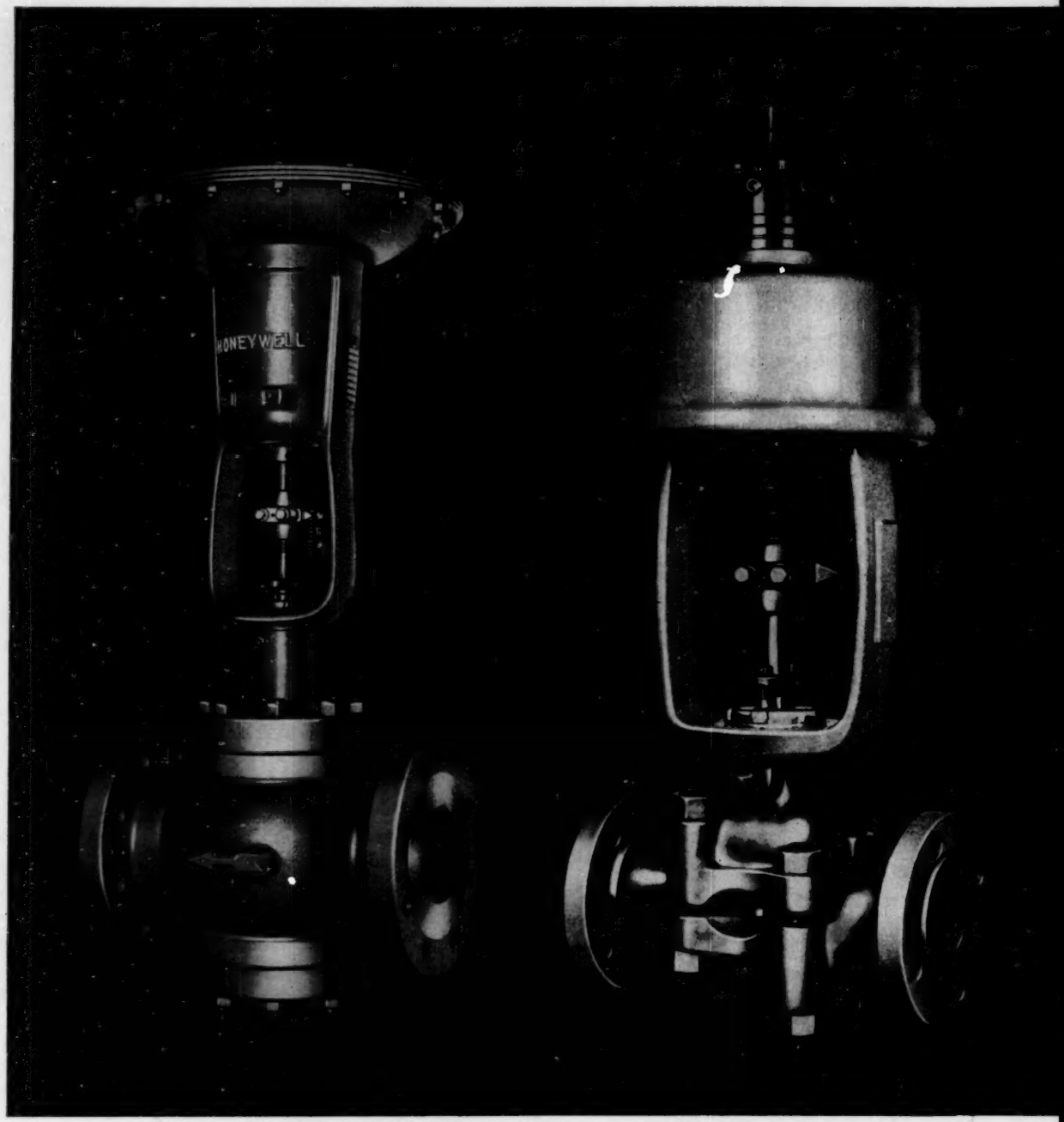
Good temperature control is one of the most important considerations in design of chemical reactors. In a series of two articles, Cornell Prof. Peter Harriott tackles this problem and comes up with some practical solutions. His first article (p. 165) deals with homogeneous reactions in tubes; it will be followed by an article on packed-bed and stirred-tank reactor dynamics.

CHEMICAL ENGINEER OR CPI SALESMAN?

Glenn Blinzler of Phillips Chemical Co. is both. Although he moved from engineering into sales five years ago, Blinzler still comes up against—and finds solutions to—many technical problems. This issue's You & Your Job feature (p. 178) shows how Blinzler's chemical engineering background helped prepare him for a successful career in sales.

NEW PROCESS FOR Ti-CLAD STEEL PLATE

Despite its outstanding corrosion resistance, titanium's high price and difficulties of fabrication have heretofore limited its usefulness to the chemical engineer. Commercial availability of titanium-clad steel bids fair to remove such limitations. Corrosion Forum (p. 194) describes Lukens' new process that now makes this possible.



The lineup, left to right—Diaphragm actuator, globe body . . . Cylinder actuator, split body . . . Diaphragm actuator, split body . . . Cylinder actuator, globe body.

Interchangeable!

MIX THEM, MATCH THEM TO THE JOB . . . AND SAVE!

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Honeywell's split-body and globe-body control valves team up beautifully with Honeywell cylinder and diaphragm type actuators. Use either actuator with either valve. The beauty lies both in the economy and perfect matching to the application made possible by this interchangeability. The "mix and match" versatility of Honeywell valves and actuators lets you select the exact degree of performance you require. No need to push a valve beyond its design limits, on one hand, or to pay for more performance than you need, on the other. You get the best valve-actuator combination for a given application, at the lowest cost. The new Honeywell "Valve Size Computer" helps you make your *mix and match* selection . . . send for yours today. MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

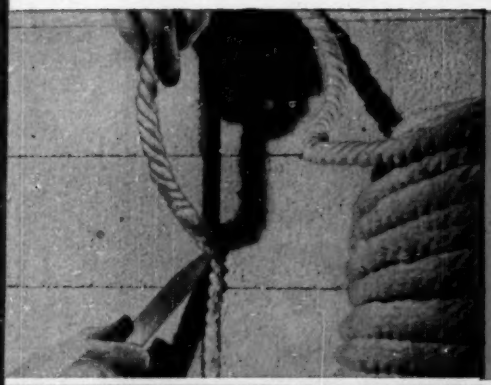
Honeywell

First in Control

SINCE 1885

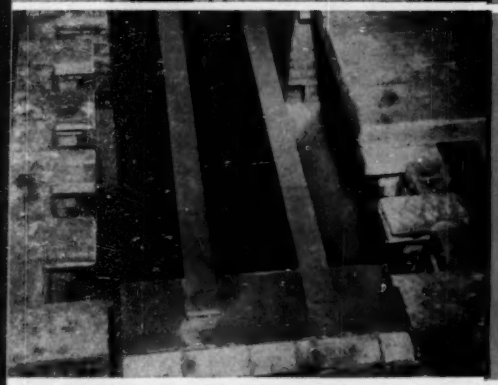
Report from Carborundum:

How industry is solving unusual problems with unusual refractories



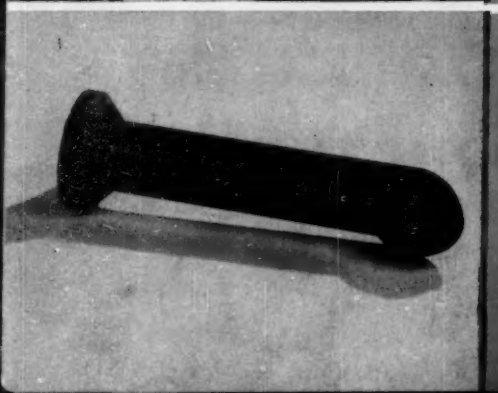
PACKING EXPANSION JOINTS:

CERAMIC FIBER WITHSTANDS 2300°F; EASILY PACKED; OBTAINABLE IN MANY FORMS. FIBERFRAX® ceramic fiber extends the temperature ceiling of fibrous insulating materials; opens new application areas. In rope or bulk form, it makes an excellent expansion-joint packing for refractory furnace walls. It is light in weight, highly resilient, does not shrink, is impervious to heat shock, and is inert to most furnace atmospheres. Various forms of FIBERFRAX — e.g. cloth, board, paper etc. — also offer advantages for gasketing, sealing, wrapping, lining, encapsulating, blanketing and jacketing.



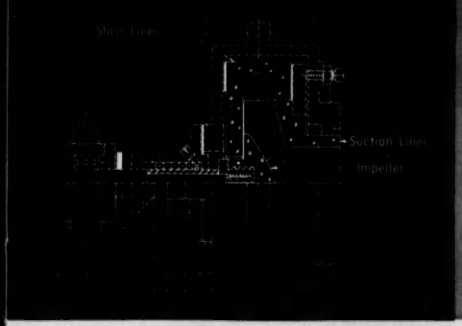
ZINC ORE REDUCTION IN VERTICAL RETORT:

RUGGED REFRACTORY WALLS CONDUCT HEAT FAST, STAY GAS TIGHT. Five million Btu's must be transferred through refractory walls such as shown at left for every ton of zinc produced. High heat conductivity — 11 times that of firebrick — is provided by CARBOFRAX® silicon carbide retort walls. Internal temperatures reach 2000°F. Other important refractory properties: great physical strength at high temperatures, chemical inertness, and unequalled abrasion and erosion resistance. Low permeability is also important because gas-vapor mixtures produced in the retort must be contained.



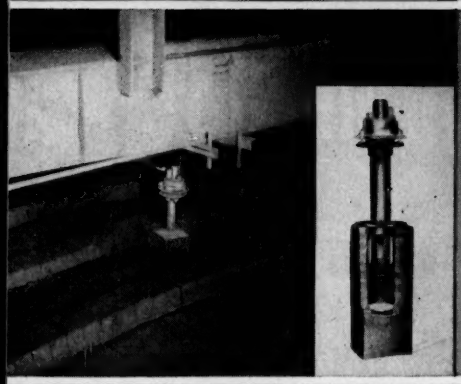
SPRAY NOZZLE FOR CORROSIVE SERVICE:

REFRACTORY REPLACES METALS—RESISTS HIGH TEMPERATURES, CORROSION, THERMAL SHOCK. The nozzle illustrated sprays a 15% solution of SO_2 in water at 150°F into a chamber operating at over 1700°F. Conditions involve severe thermal shock and corrosion. Previously used metal nozzles often lasted less than two months. Nozzles made of Carborundum's silicon carbide have shown no signs of failure after five years of service — another example of how these versatile refractories can take unusual forms to meet highly specialized problems.



PUMPING ABRASIVE SLURRIES:

REFRACTORY PARTS FOR PUMP RESIST WEAR, OUTLAST HARDEST METAL ALLOYS. Development of REFRAXE, a silicon-nitride-bonded silicon carbide, makes it possible to use refractories in many applications usually requiring metals. It can be formed with high dimensional accuracy as well as a high finish. Examples of use are impellers and shell liners in "Lightning" sand and gravel pumps made by Kansas City Hay Press Co. Comparative performance during a six months' test pumping 150 GPM of water with 20% silica sand against a 70-foot head has shown that REFRAX parts give more than five times the life of duplicate parts made of nickel chrome alloy.



MAKING 200 TONS OF STEEL BEHAVE:

TARGET BLOCK HELPS KEEP FURNACE TEMPERATURE AT MAXIMUM PRODUCTION LEVEL. The temperature detector shown in the open hearth roof at left is mounted in a hollow silicon carbide block. The detector is focused on a target disc made of another one of Carborundum's refractories — REFRAX refractory. Radiated heat from the disc provides a constant check on roof temperature . . . assures maximum production without danger of "losing" the roof. These two refractories provide the necessary properties of high heat conductivity, resistance to high temperatures and furnace gases and exceptional hot strength. Device is manufactured by Leeds & Northrup Co.

FIRING ELECTRICAL PORCELAINS:

SILICON CARBIDE KILN FURNITURE SIMPLIFIES CAR SETTINGS, PROTECTS WARE; IMPROVES HEAT CIRCULATION. Kiln car at left is loaded with electrical insulators supported by CARBOFRAX silicon carbide tile, posts and girders. Setting enables car to carry maximum load; may be rearranged as needed to suit different sizes of ware. CARBOFRAX furniture possesses high hot strength, resists deformation, reduces breakage losses — in trip after trip through the kiln. Furniture is also designed to permit uniform circulaton of heat through and around car for best ware firing conditions.

SINTER-PLANT DUST COLLECTOR:

REFRACTORY LINING LASTS YEARS IN SERVICE INVOLVING HIGH-VELOCITY GAS AND ABRASIVE PARTICLES. Superior resistance to entrained abrasive particles is shown by a lining made of a Carborundum-made refractory in this primary dust collector. Cone lined with Carborundum's material has handled more than 2,500,000 lbs of abrasive sinter dust in seven years. Ordinary brick in other parts of the same collector has worn back to the shell in only 5 months. Other wear-resistant applications for Carborundum's refractories are in duct linings, blast furnace downcomers, hydro cyclones, chutes, bins, feeder tables, gas scrubbers, nozzles and other related applications.

Want help on your problems?

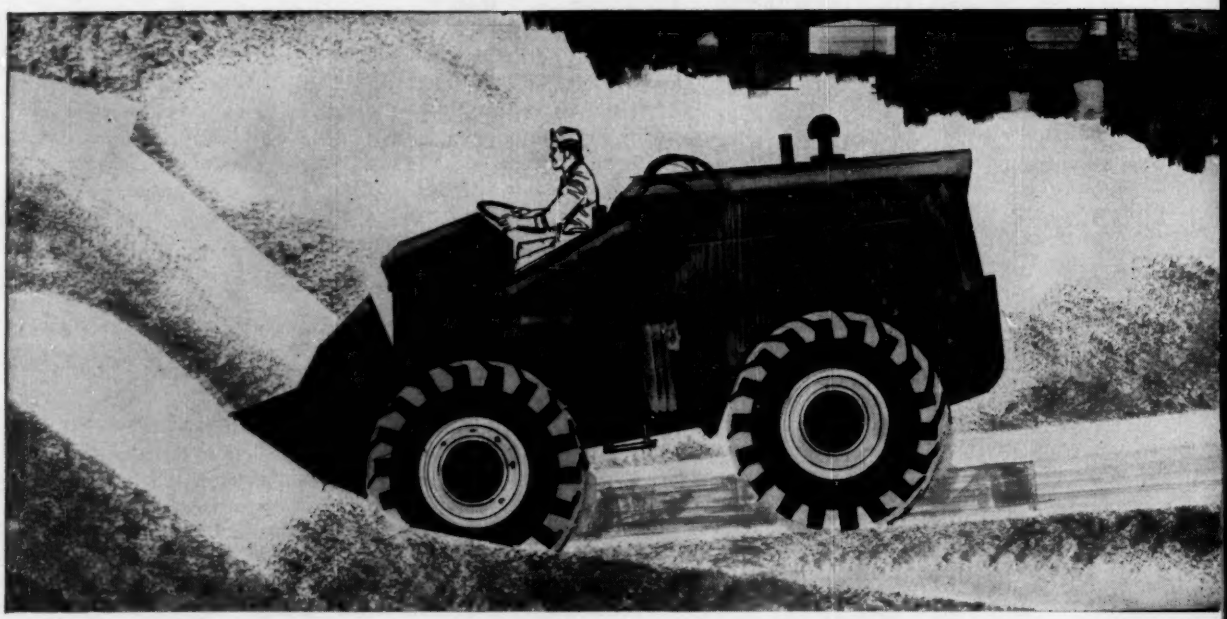
Carborundum engineers will be glad to recommend refractories to answer your specific needs. For information, contact Dept. H-51, Refractories Division, Carborundum Co., Perth Amboy, N. J. Descriptive brochures available on request. Please specify the area or areas of particular interest to you.

for engineered refractories . . . count on

CARBORUNDUM®

ARMOUR IDEA CHEMICALS

Armoflos

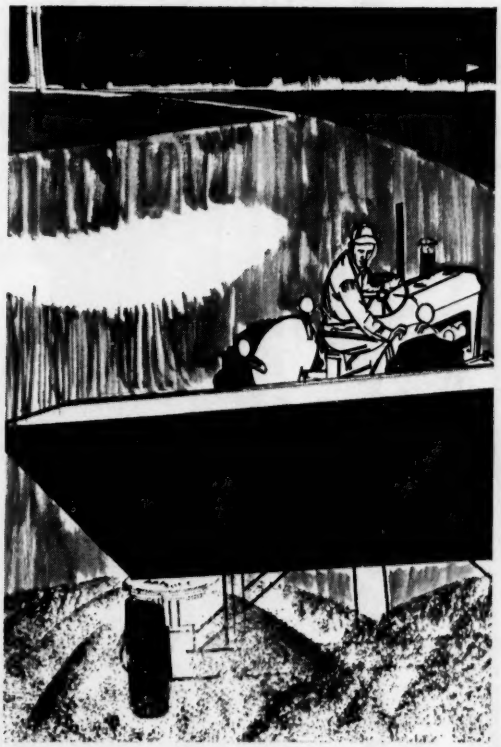


ARMOFLO* COMPOUNDS were developed by the Armour Industrial Chemical Company to prevent the caking of hygroscopic fertilizers and inorganic salts. During initial trials with these chemicals, they performed as effectively in controlling dust as in preventing caking. They have since proved valuable as anti-cakers and anti-dusters in the production of fertilizers, fertilizer salts, sulfur, thermo-setting resins, insecticides, caustic soda, and detergents.

**Armour and Company trade-mark*

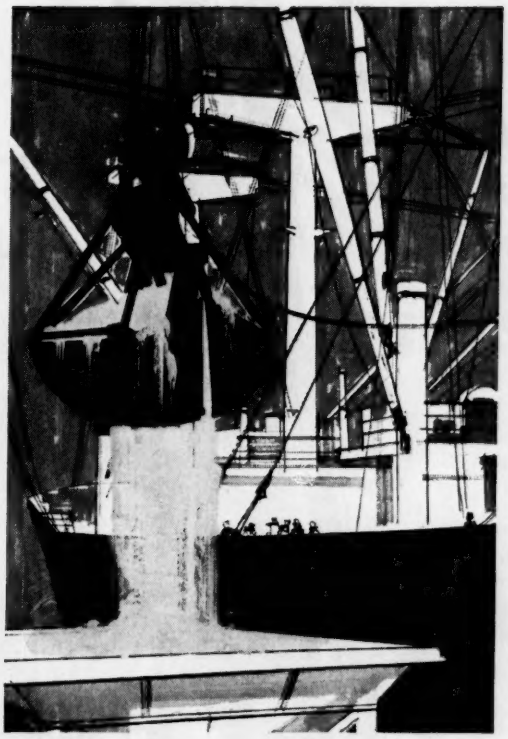
Armour Industrial Chemical Company

One of the Armour Chemical Industries • 110 North Wacker Drive • Chicago 6, Illinois



ANTI-CAKERS

The ability of Armoflos to coat a hygroscopic salt with a monomolecular hydrophobic surface prevents caking in mixed fertilizers and single salts—even after extended storage. The easiest way to attain proper conditioning: spray Armoflo on finished product during any rolling or mixing operation in the presence of heat. Besides conditioning fertilizers, Armoflos have shown promise in the treatment of rock salt and detergent formulations. They also are now being tested by chemical, plastic, rubber and ceramic producers.



ANTI-DUSTERS

Armoflos have helped solve the dusting problems associated with the crushing, grinding, blending and transporting of both coarse and fine materials. Coating the particles with a monomolecular film of Armoflo allows them to move freely over one another, thereby reducing abrading and the formation of finely divided particles. This minimizes the health hazard of air pollution to personnel, the possibility of fire and/or explosion, and product loss. These Armour chemicals are economical to use. For example, one pound of Armoflo per ton of either high- or low-analysis fertilizer controls both caking and dusting.

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To see how Armour Armoflos can help your operation, send the coupon.

ARMOUR INDUSTRIAL CHEMICAL COMPANY
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☐ Please send me a copy of your Armoflo booklet.
☐ Please send me a sample for conditioning

(Name of your product)

Name.....
Company.....
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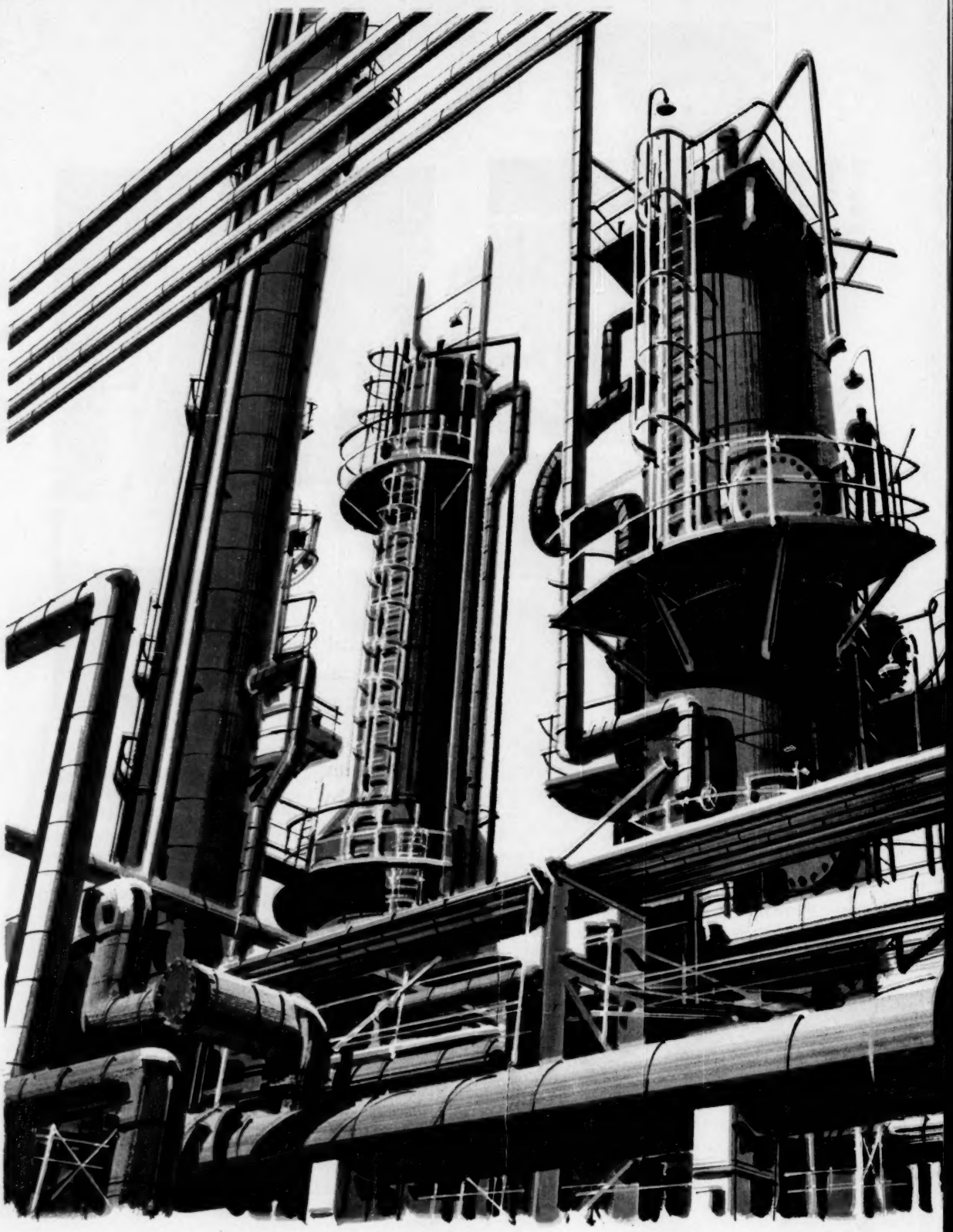
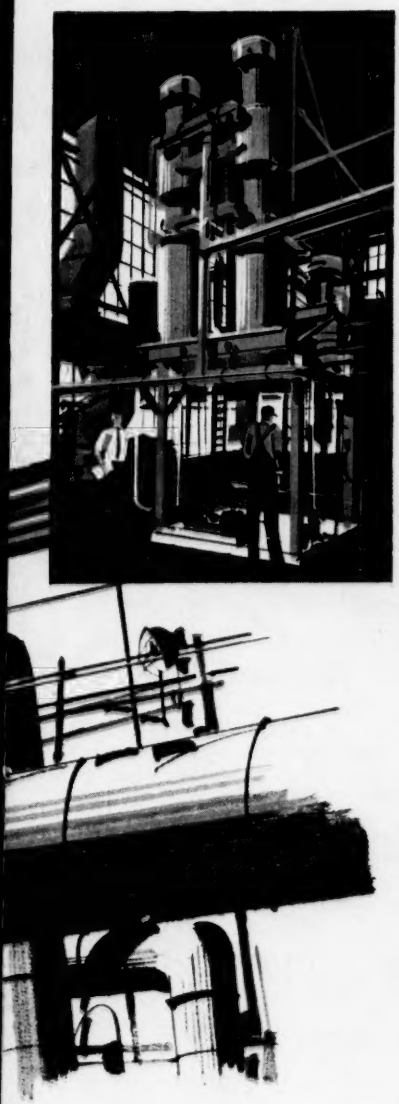
City.....Zone.....State.....





Scale-up the profit in your process

How can a processor scale-up a new process from pilot plant to large commercial installation and bring it to profitable operation without a long and costly start-up period?

The Foster Wheeler method is thoroughness. FW avoids or minimizes major stumbling blocks by careful attention to detail . . . by thoroughness firmly supported by careful organization and solid experience.

Examples are: the scale-up of a urea plant from 3 to 260 tons per day; a new FW deasphalting process from 1 to 10,000 barrels a day and a 300 ton per day ammonia plant that exceeded rated capacity 30 days after erection.

Whether for a proven process or scale-up project, FW gives you the thoroughness and experience you need—in design, engineering and construction—to build your process plant . . . any capacity . . . any process . . . anywhere in the world. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

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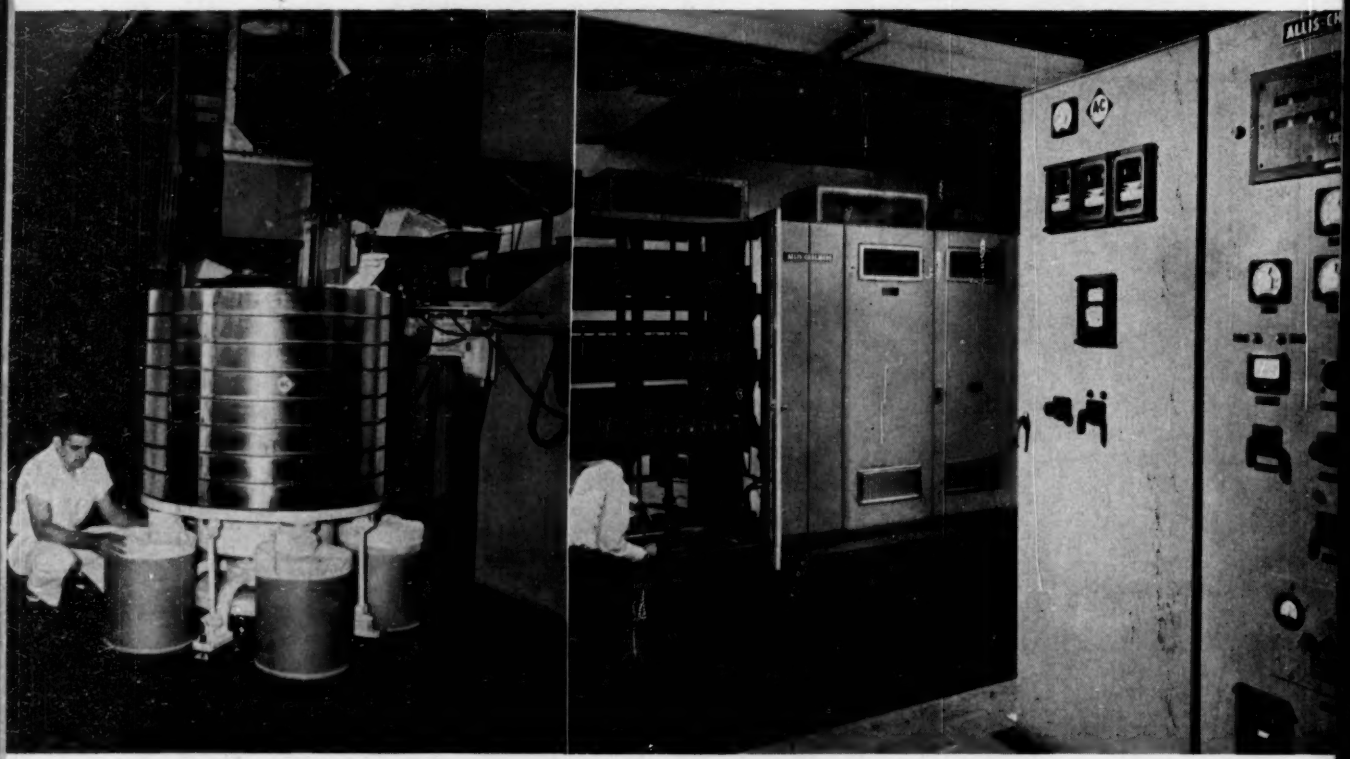


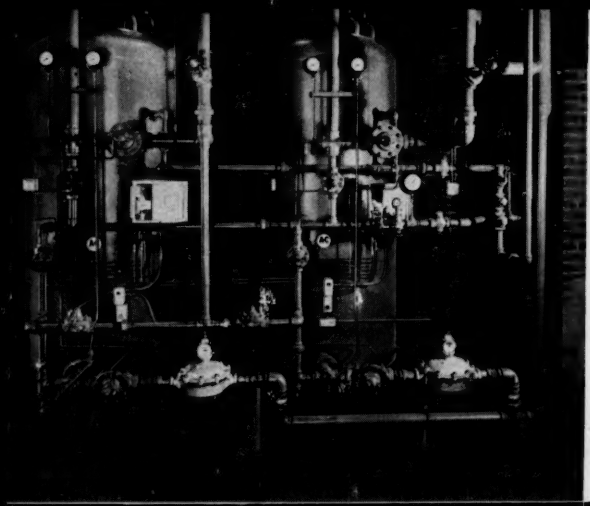
Up to 35 square feet of screening area in only 16 square feet of floor space: Stacked-deck design of this gyratory screen conserves valuable space. Cuts maintenance, downtime with all-stainless-steel construction. Abrasive or corrosive materials, dry foods and pharmaceuticals are handled with care. Gentle, quiet, vibrationless operation means minimum disintegration of fragile particles.

Silicon rectifiers can be located anywhere in the plant. Designed especially for large electrochemical or industrial applications where space, heat or dirty atmospheres are a problem, these silicon rectifiers employ water-to-water heat exchanger equipment. No special room is required — no need for clean air for cooling. Smaller compartment sizes save floor space. Cells can be removed without disturbing the cooling system. Reactor cores eliminate need for matched cells, surge capacitors protect against voltage surges, and current-limiting fuses provide cell protection.

Which of these productive ideas could be working for you?

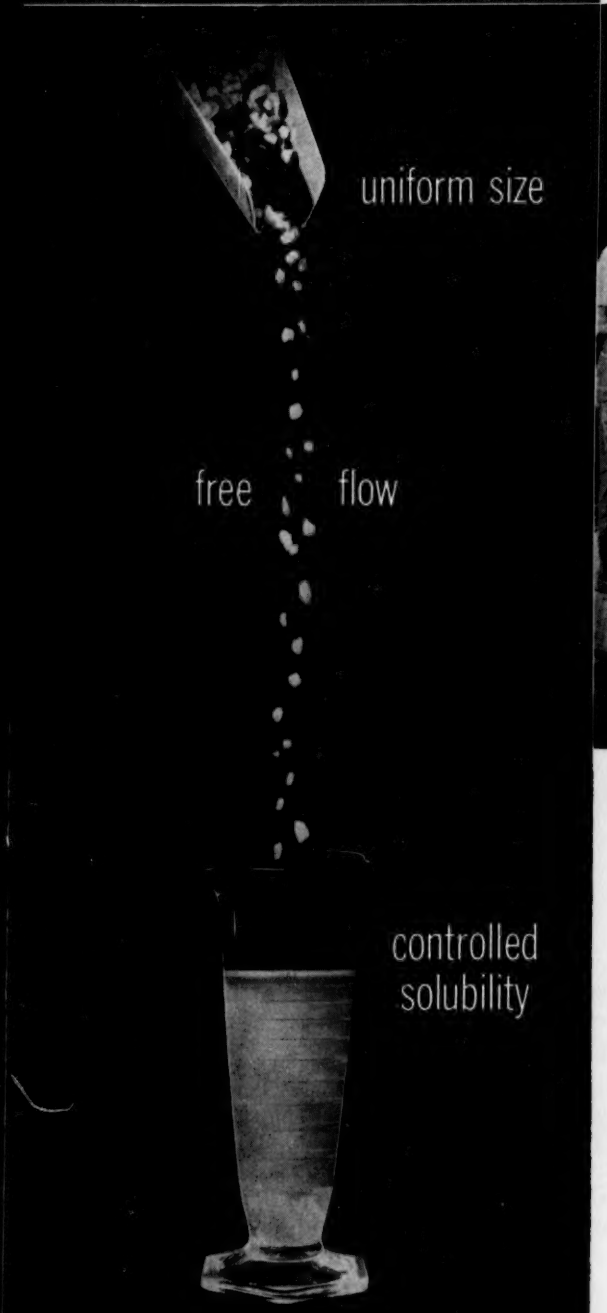
A continuous mechanical agglomeration process that makes waste materials pay. A steam turbine-generator with dual-purpose flexibility. A gyratory screen that saves space. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

A-1480



Calcium and magnesium are the "vandals" that cause scale in pipes and boilers, clog systems and mean heavy use of cleaning compounds. ZEOLITE is their natural enemy! An A-C zeolite water softener means a simple switch to sodium ions from the usual hardness present in most water supplies. Once A-C conditioned, the "softened" water finds ready use in chemical plants to end scaling problems.

Even the by-product makes an economy contribution: Versatile . . . describes these two 6250-kw condensing, automatic extraction steam turbine-generator units installed in a midwest petrochemical plant. A typical application supplying steam to a process with electric power as an economical by-product. A-C manufactures a complete line of condensing and non-condensing turbine-generator units, with or without automatic extraction, for the chemical industry. For complete information on types and ratings from 2000 kw to the largest, ask for bulletins 7654A and 9448.



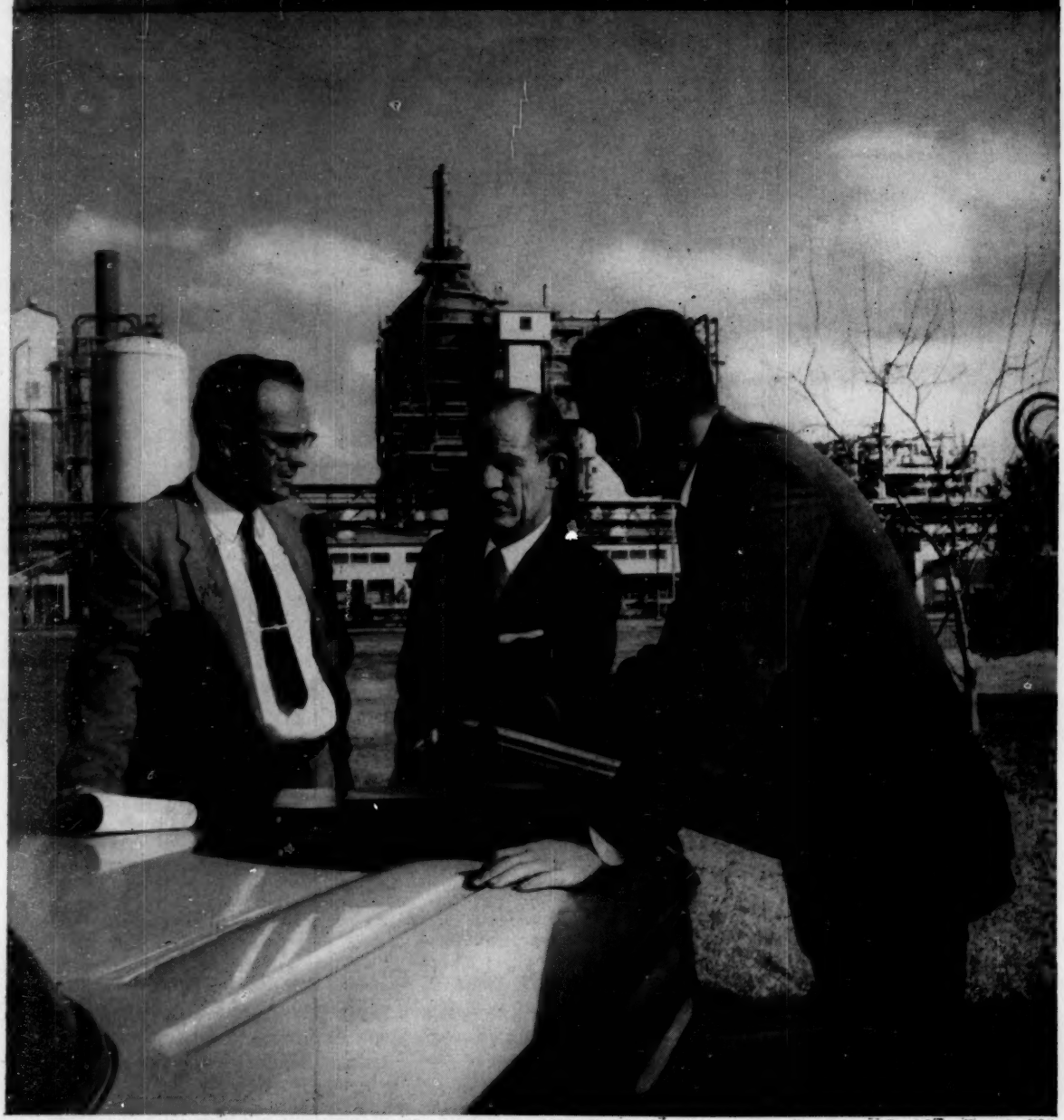
Profit recovery starts with waste: The continuous mechanical compacting process recovers virtually 100% of waste fines! It compacts and screens your waste material into flakes. Then granulates them into desired product. The same process tightens your production controls when you face problems involving granular size, density, solubility and other physical properties. Integrates smoothly into your system. Requires less power, lower capital investment than less modern agglomeration methods.

ALLIS-CHALMERS PRODUCTS FOR THE CHEMICAL INDUSTRY: Look to A-C for atomic, thermal and hydro electrical generating equipment; Compactor mills; compressors; control; coolers; crushers; dryers; earth-moving equipment; engines; grinding mills; industrial systems; kilns; lift trucks; motors; pumps; rectifiers; screens; switchgear; tractors; transformers; unit substations.

ALLIS-CHALMERS

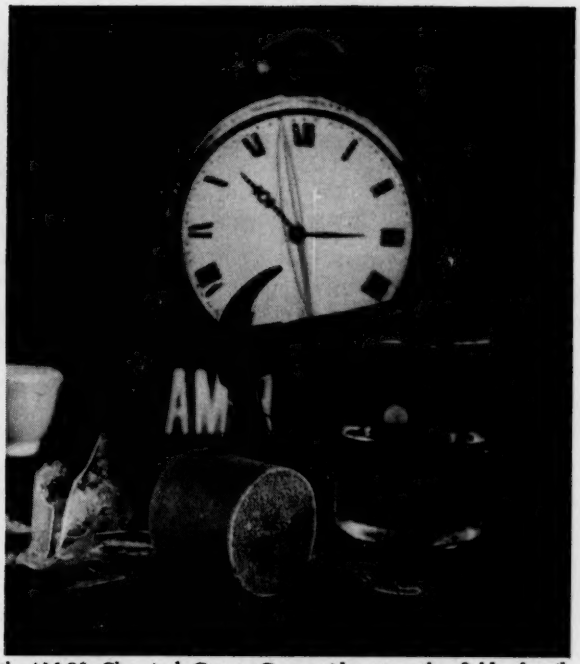
CYANAMID

Chemical Newsfront



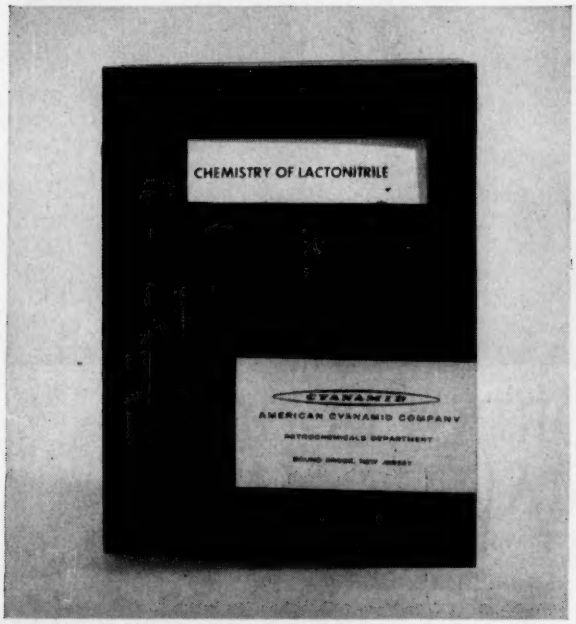
IMPROVED REFINERY YIELDS WITH CYANAMID'S CRACKING CATALYSTS. AEROCAT® 3C catalysts give refiners more flexible and profitable operations. These three component fluid cracking catalysts yield more gasoline, propylene, and butylene at the expense of dry gas and coke. Cyanamid representatives continually work with petroleum refiners to determine the suitability of AEROCAT 3C to their cat cracking operations.

(Refinery Chemicals Department)



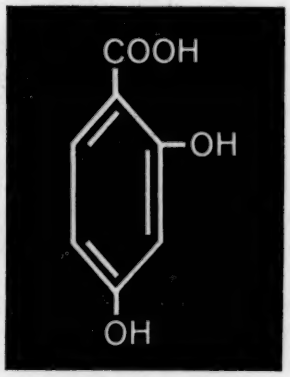
AMAZING NEW CHEMICAL CHANGES THE EARTH'S CONSISTENCY. With AM-9* Chemical Grout, Cyanamid enters the field of soil stabilization. Illustrated above, we see AM-9 transforming porous soil into impervious matter. The powdery chemical may be dissolved in water right at a construction site. Catalysts are added and the mixture is pumped into drilled holes. Result: Ground through which water cannot flow. **(Organic Chemicals Division)**

*TRADEMARK



LACTONITRILE — INEXPENSIVE, BIFUNCTIONAL RAW MATERIAL. This chemical is convertible to a host of useful intermediates. Among these are lactic acid, ethyl lactate and, in combination with other products, a filler for nitrile-containing plastic materials. For the full story, send for the above booklet checking the appropriate area on the coupon. **(Petrochemicals Department)**

FORMULA FOR A WIDE RANGE OF REACTIONS. Cyanamid's Beta Resorcylic Acid, a versatile starting material for the preparation of commercial organic compounds, is available from plant production. High purity, low color and low density, coupled with its reactivity, suggest uses where resorcinol or salicylic acid is now employed. **(Market Development Department)**



CYANAMID

AMERICAN CYANAMID COMPANY
80 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on products in this advertisement wire, or mail this coupon to: **CE-51**

AMERICAN CYANAMID COMPANY
30 Rockefeller Plaza, New York 20, N. Y.
Dept. 6362

Please send me additional information on

- ☐ **AM-9 CHEMICAL GROUT**
- ☐ **LACTONITRILE Technical Booklet**
- ☐ **BRA (Beta Resorcylic Acid)**

Name_____

Company_____

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Address_____

City_____ **Zone**____ **State**_____

FLUIDICS* AT WORK

TITANIUM CHLORINE COOLER REQUIRES NO MAINTENANCE

If you talked with the people at Stauffer Chemical Company, Niagara Falls, N. Y., you'd find they are not concerned that this chlorine gas cooler is located in a relatively inaccessible spot.

In fact, you'd learn that they placed it here deliberately in order to save production space within their plant.

Why? It's made of titanium.

No down time. Installed in Cellhouse No. 1, where a heavy tonnage of chlorine is cooled daily, this 394 sq. ft. Pfaudler® heat exchanger cools chlorine gas from 75° to 40° C. Unlike the other coolers at Stauffer, this titanium unit has required *no* maintenance whatsoever since going into operation late in 1959.

Zero corrosion. This performance record is due to the fact that titanium is completely immune to corrosion by wet chlorine. Because of this, you can locate such coolers without regard to headroom. You don't have to worry about getting at them for inspection, cleaning, or other maintenance.

Sound investment. Moreover, the almost infinite service life of titanium in wet chlorine makes such a cooler an exceptionally sound investment. Compare titanium with other materials, taking into account length of service expected and maintenance required, and the economics of titanium will be apparent.

Availability. Along with titanium, Pfaudler also provides production-sized equipment made of tantalum and zirconium. For the full story, ask for Bulletin 978 —*Titanium, Tantalum and Zirconium Process Equipment by Pfaudler.* Address your inquiries to the address shown on the facing page.

On stream with Pfaudler

This could be your new plant. And one of the men at the site could be from our Field Service group.

His job? Supervising the installation of Pfaudler equipment. Giving expert attention to every detail during uncrating, rigging, erection and hook-up. Assuring operational efficiency.

Such responsibility is the task of our 15-man Field Service staff. The eldest in the group has been servicing Pfaudler equipment for 25 years. The rest? Varying amounts of time. All bring specialized knowledge and skills to the job; the kind that pay off handsomely for you.

These specialists now also offer complete *start-up service*. They check out the equipment, along with your piping—make sure you go on stream with complete confidence.

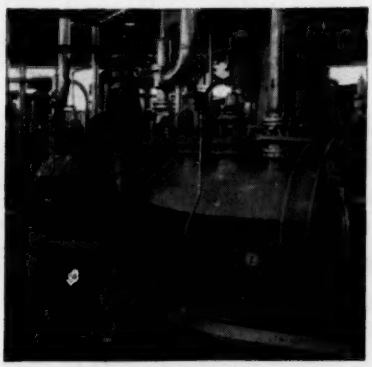
Emergency service is also part of our Field Servicemen's job. Like? When a fire damaged a customer's plant, a Pfaudler tank needed extensive repairs. Our men had the tank removed from the line, shipped it to our plant, and then reinstalled it—*all within a single week.*

These 15 men are strategically located throughout the country. Their services are literally as close to you as your phone.

For more details and cost information, call BEverly 5-1000 in Rochester, New York, and ask for CUSTOMER SERVICE. From then on, *your* problem is ours!

Glasteel helps set records with PVC

High yields, complete protection for product purity, and minimum down time is the story at Cumberland Chemical Corporation's plant (jointly owned by Air Reduction Company Inc. and The Ruberoid Company) at Calvert City, Kentucky.



Playing a major role in this record-setting performance are 14 Pfaudler Glasteel reactors. With good reason. Glasteel—glass inside, steel outside—is the ideal material for polymerization.

Its surface is corrosion resistant and exceptionally smooth, so PVC does not react with it or readily adhere. This keeps product losses down. It also means that complete cleaning is quick and sure. You can do it between batches with the Pfaudler glassed Spray Rinse valve.

And, Glasteel will not contaminate or discolor any of the materials you use in making resins. Let us answer your questions in detail; ask for Bulletin 932.

Dimpled jacketed stainless reactors now rated at 180 psi

Dimpled jackets in themselves provide more effective heat transfer and higher pressures than heavier wall conventional jackets.

But, build them out of *Inconel* and you further extend design performance.

Now you can operate Pfaudler stainless steel reactors to 180 psi jacket pressure against full vacuum or a 75 psi internal. Inconel, as you would guess, is the jacket material.

Higher jacket pressure is one advantage, but an Inconel dimpled jacket offers these additional features:

1. Use any conventional jacket-heating medium including the chlorinated hydrocarbons and chloride brines.
2. Forget about surface corrosion on both inside and outside of the jacket.
3. Eliminate any concern you might have about stress-corrosion cracking.

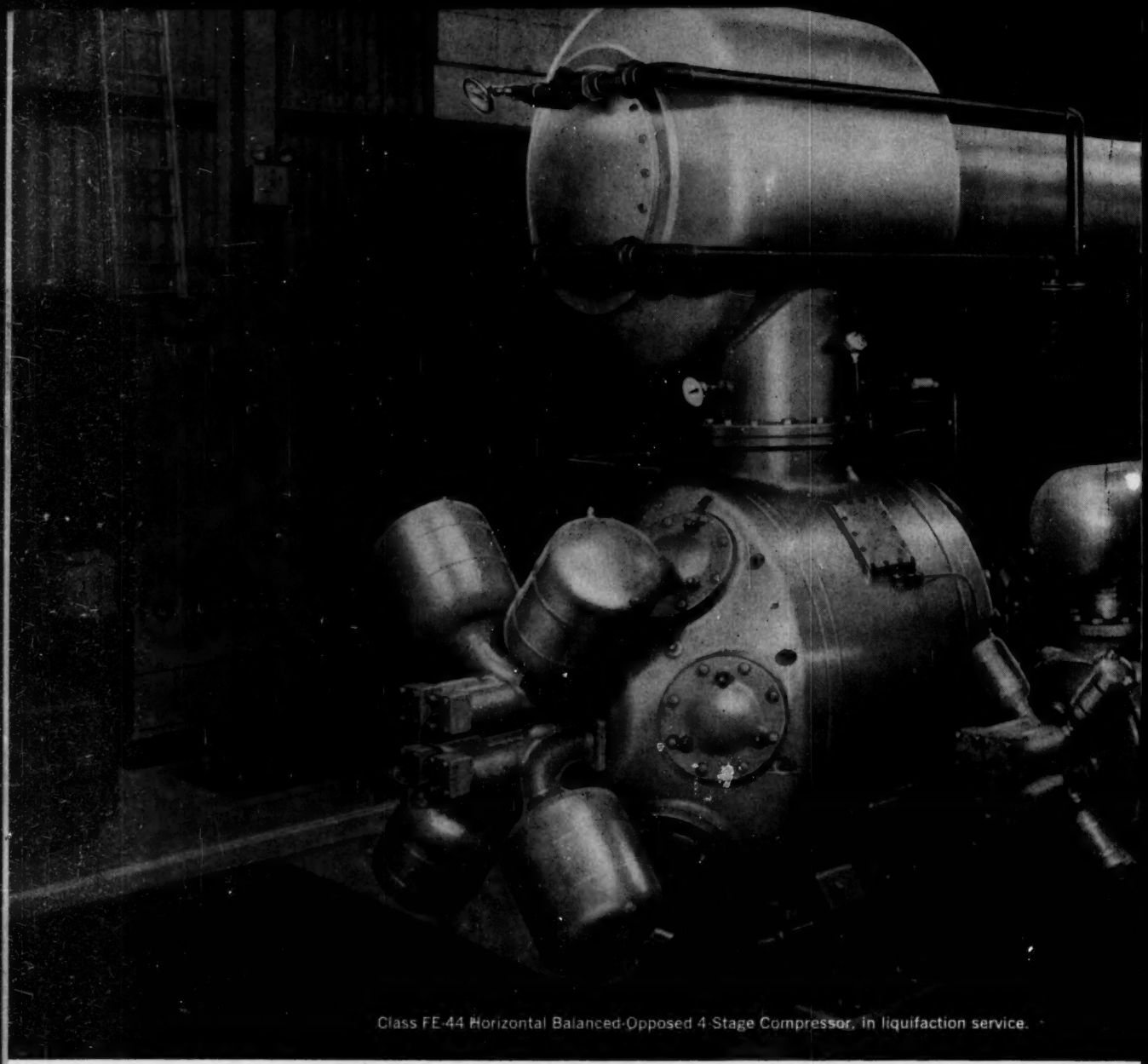
Inconel dimpled jackets are standard on all Pfaudler stainless steel reactors of from 750 to 4,000 gallons. Complete specifications are included in our *new* Bulletin 1005. For your copy, write to the address listed below.

Address all inquiries to: Pfaudler Division, Dept. CE-51, Rochester 3, New York.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes



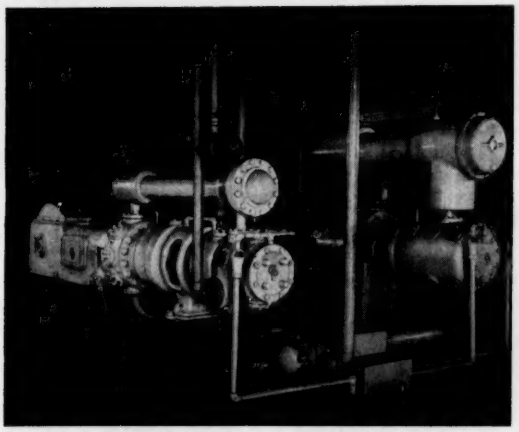
Class FE-44 Horizontal Balanced-Opposed 4-Stage Compressor, in liquifaction service.

meet all High Pressure Demands with

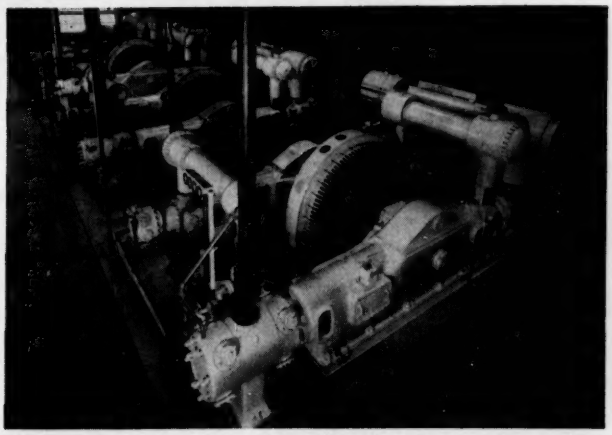
CP MULTI-STAGE AIR and GAS COMPRESSORS

Gas liquifaction and other processes demand compressors that will produce high pressures and take continuous heavy duty in stride. CP Multi-Stage Compressors – Class FE's, H-CE's and O-CE's, for example – are meeting these exacting demands in a wide variety of applications. CP designs for such rigid requirements are available in horsepowers to 5,000, and pressures to 15,000 pounds. Write for detailed specifications.

Chicago Pneumatic 8 East 44th Street, New York 17, N. Y.

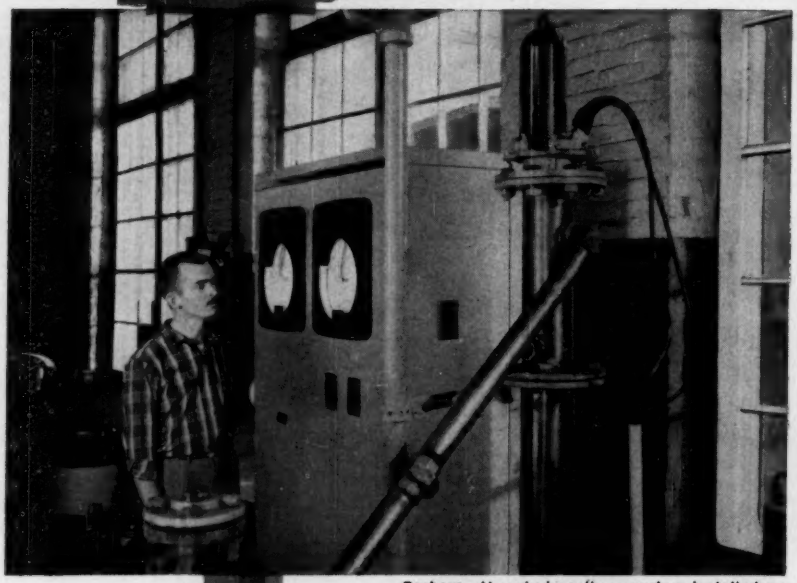


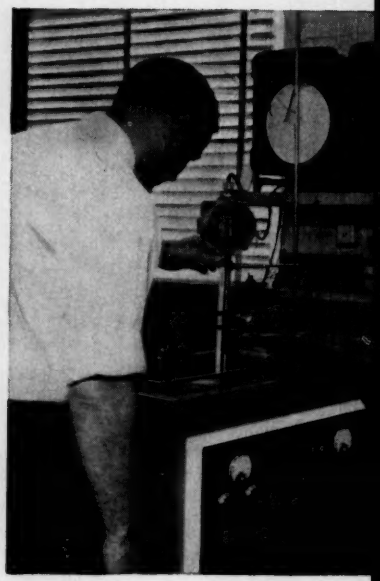
Class O-CE Horizontal Duplex, 4-Stage 250 hp Compressor in an oxygen plant.



Class H-CE-5 synchronous motor-driven, 5-Stage Compressors in a chemical plant.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



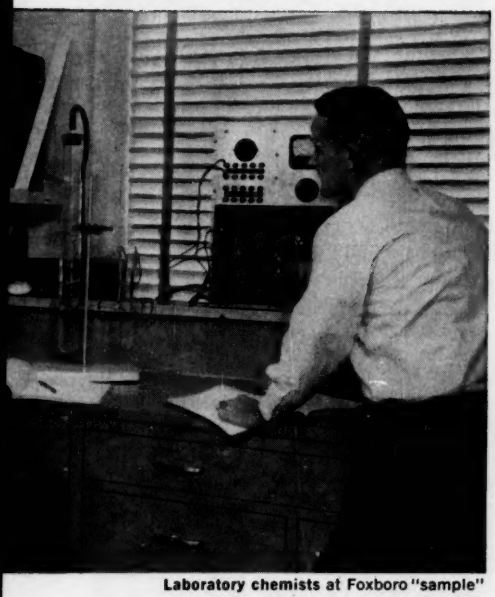


Foxboro pH and viscosity recorders installed on process control panel in a large chemical plant.

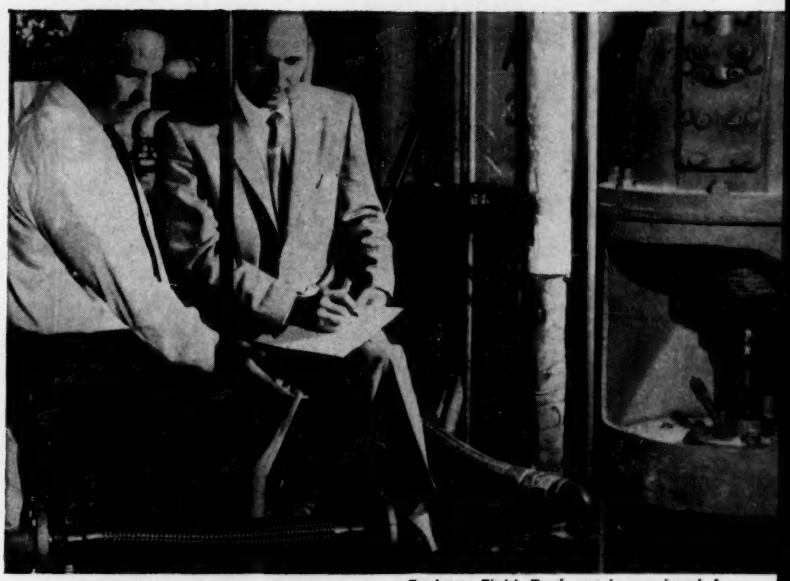
from Foxboro...

the analyzers...the electro-chemical

to help solve your



Laboratory chemists at Foxboro "sample" customer's process fluids to determine dielectric constant and conductivity.



Foxboro Field Engineer is on hand for his customer's all-important start-up day.

know-how...the engineering service process analysis problem!

pH, conductivity, amperometry, dielectric constant, oxidation-reduction potential . . . no matter what analytical measurement characterizes your process, chances are Foxboro can make it for you.

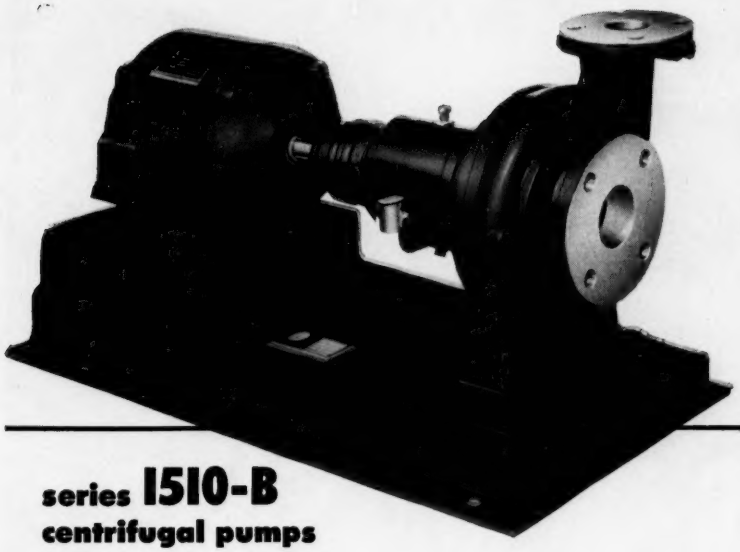
Foxboro's wide range of instrumentation covers the entire control loop. Measuring elements, transmitters, recorders, controllers, alarms — all installed as an integrated system. And all under the single responsibility of The Foxboro Company.

What about your process? Are guesswork, or slow, hand-sampling techniques hampering your operating efficiency? Why not put Foxboro to work analyzing your process stream continuously — automatically? Ask your nearby Foxboro Field Engineer for details. Or write Foxboro's Analytical Department for complete information. The Foxboro Company, 365 Neponset Avenue, Foxboro, Massachusetts.

Some of the analytical measurements Foxboro can make – pH • Oxidation-reduction potential • Dielectric constant • Amperometry • Conductivity • Viscosity • Boiling point rise.

FOXBORO

REG. U.S. PAT. OFF.



NOW AVAILABLE IN "C" SIZE UNITS UP TO 75 H.P.

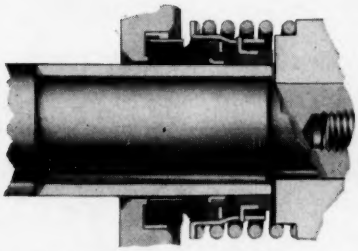
series 1510-B centrifugal pumps

HIGHER HEADS, GREATER FLOWS AT 1750 RPM!

Now, to its unequalled array of outstanding features, the B&G Series 1510-B Pump adds still another—*a broad range of ratings up to 75 HP*, with capacities to 2000 GPM, heads to 170 ft. and discharge sizes of 3″, 4″, 6″, 8″.

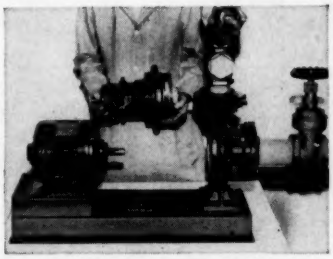
The series 1510-B is a vertical split-case pump designed for smoother, more efficient operation and longer life. Its balanced design enables the bearings to withstand loads far in excess of those developed by any pump and motor combination in the line.

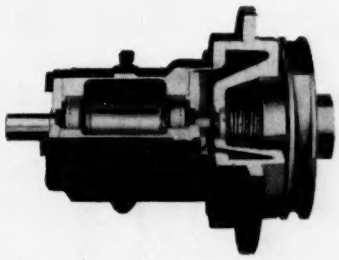
All parts are machined to rigid specifications, carefully inspected and accurately assembled, to insure minimum installation and maintenance expense. Exact uniformity of all parts means easy replacement in the field. All pumps are factory-tested for conditions of head and capacity specified.



LEAKPROOF "REMITE®" SEAL

This exclusive feature assures long, trouble-free life—eliminates the customary leakage which occurs when a packing gland is used. A Carbon Seal Ring faces on a "Remite" floating seat—*a new type of material so hard it will scratch glass—wear-proof and corrosion-resistant.* This Mechanical Seal is self-lubricating. A synthetic rubber bellows seals the shaft. Metal parts are of steel, bronze, or stainless steel, depending upon the type of service.





REMOVABLE BEARING FRAME MAKES SERVICING EASY

The photo shows how easily the complete bearing frame, including the seal and impeller, can be removed without disturbing piping or motor leads. The unit is replaceable and interchangeable in all pump sizes within limits of material construction.

Just five simple steps are required: 1. Loosen coupler set screws. 2. Slide coupler halves back on motor and pump shafts. 3. Remove center drop-out section. 4. Remove volute cover cap screws. 5. Lift out complete bearing frame assembly.

Among the features of the bearing assembly are anti-friction roller bearings to handle thrust and radial loads ...mechanically balanced impeller...oil lubrication.

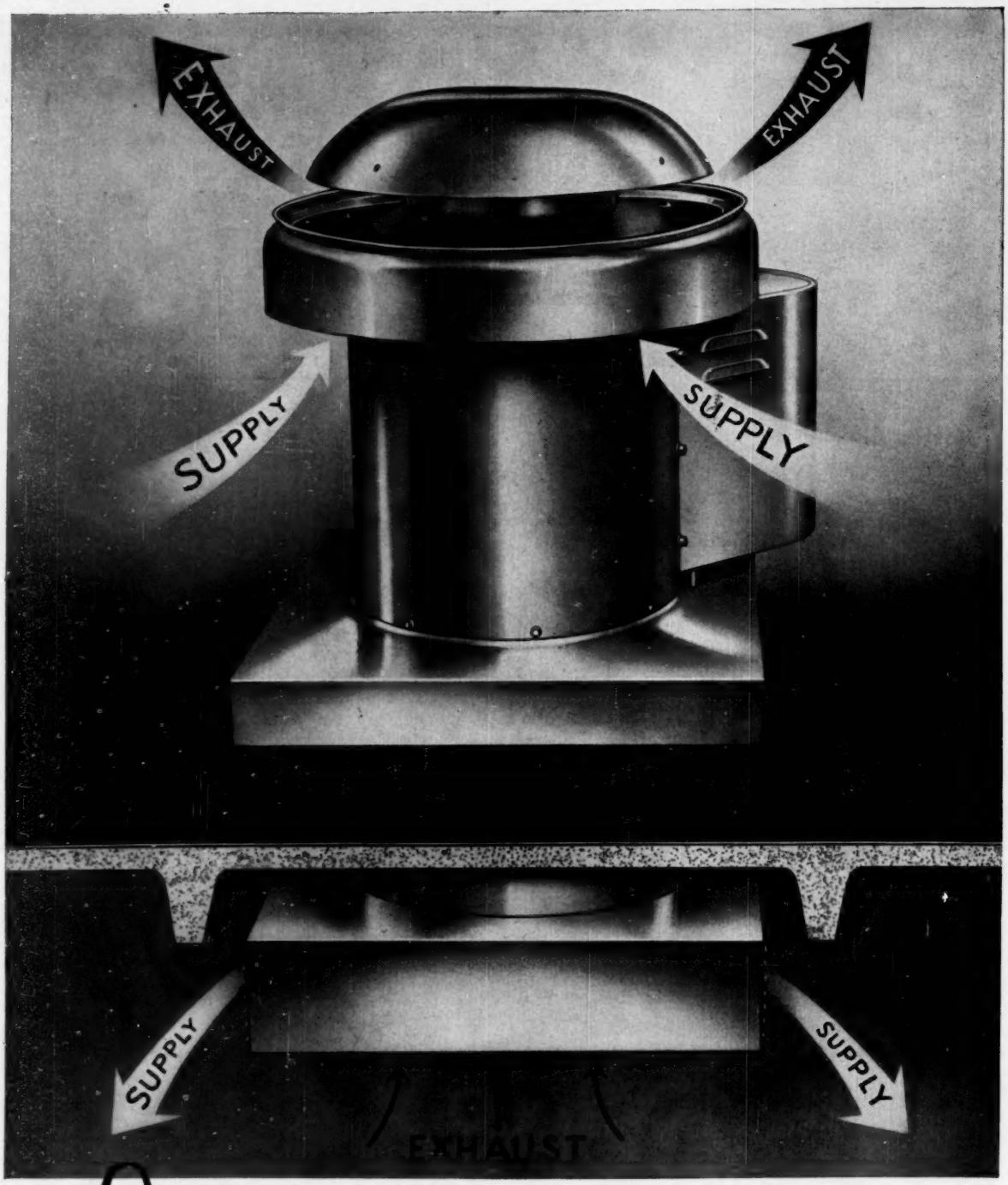
STOCK PUMPS FOR QUICK SERVICE

Selected sizes of B&G Series 1510-B Centrifugal Pumps, as well as Series 1522 and 1531, are stocked at the factory for immediate shipment. Capacities to 225 GPM, heads to 140 ft. Send for Price and Selection Catalog.

BELL & GOSSETT COMPANY

Dept.GQ-14,Morton Grove, Illinois

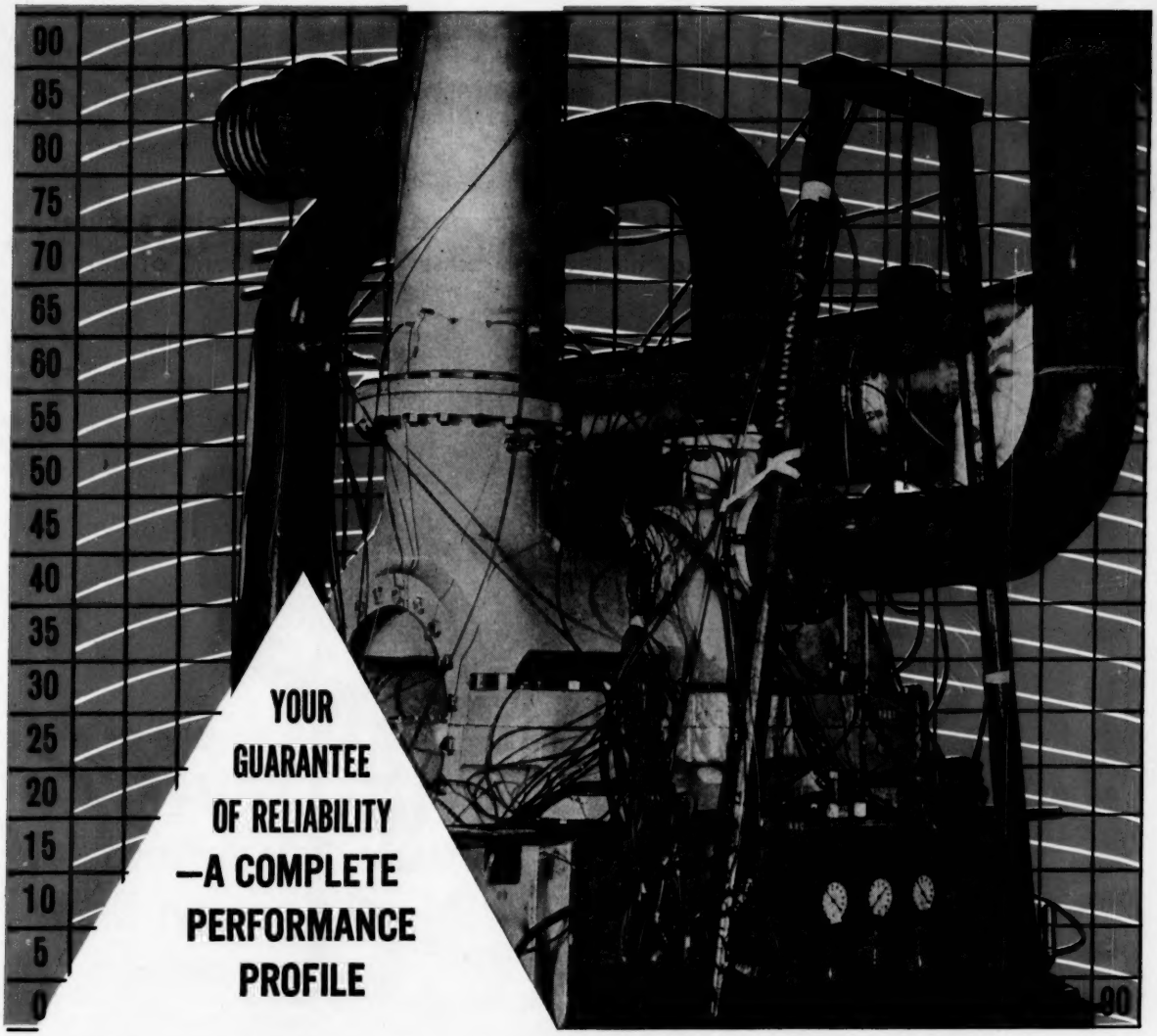
Canadian Licensee: S.A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario



One impeller does it

You get both air supply and exhaust simultaneously with the new Clarage TWINALATOR*. Unique, superior dual function air handling for all types of buildings. Definite money-saving advantages: Requires only one opening, one motor, one drive, one starter. No make-up air unit necessary. Applications unlimited — well adapted to closed or semi-closed systems. Can be provided with heating coils and filters. Write today for Bulletin 552. CLARAGE FAN COMPANY, Kalamazoo, Michigan. Clarage sales engineering offices are located in all principal cities.

*Patented Trademark



JOY DYNAMIC COMPRESSORS

Joy testing procedure gives a complete performance profile of every dynamic compressor manufactured. Costly process shutdowns can be avoided, because critical performance data under various inlet and discharge conditions are known from actual tests. Temperature and pressure readings are taken at ten different points on each compressor under eight sets of conditions.

The performance profiles are but one of the "plus values" offered with all Joy Dynamic Compressors. If your particular process requirements create special demands for higher efficiency, fewer stages, space and weight limitations, or special seals, Joy engineers are prepared to evaluate and design compressors to fit your particular needs.

Joy offers dynamic compressors in sizes from 15 to 15,000 hp, as well as a line of reciprocating compressors from 15 to 1250 hp. Consult your Joy representative whenever you need machinery for compressing air or gases. For further information on Joy Dynamic Compressors, write for Bulletin 2563-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

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accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

ASHCROFT PRESSURE GAUGES

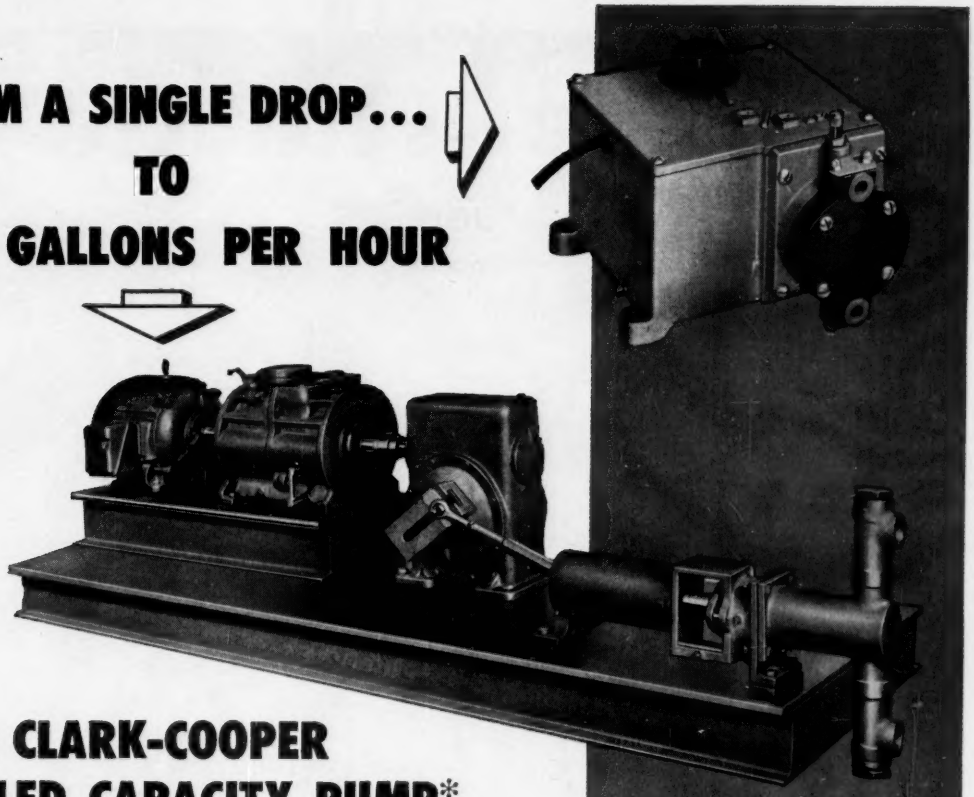
A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

FROM A SINGLE DROP... TO 3400 GALLONS PER HOUR



There's a CLARK-COOPER CONTROLLED CAPACITY PUMP* for continuous, accurate metering of all types of liquids

CLARK-COOPER CONTROLLED CAPACITY PUMPS are precision-built to accurately measure and transfer liquids, slurries and suspensions at a specific, adjustable rate of flow, regardless of pressure variations in the system.

FROM BASIC SIMPLEX MODELS with a capacity of one drop every 13 strokes at pressures of 10,000 P.S.I., to quadruplex models with capacities of 3400 GPH, there's a Clark-Cooper CC pump for your specific application . . . with job proven volumetric metering at repeatable accuracies of ±½%.

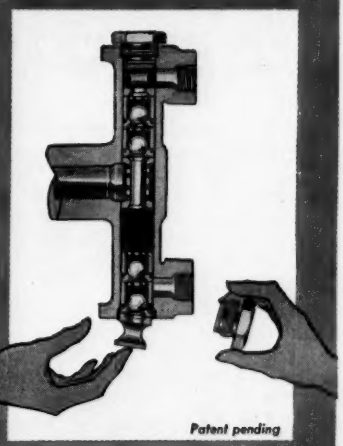
FUNCTIONALLY INTERCHANGEABLE Clark-Cooper pumps are manufactured in both diaphragm and plunger type construction. Conversion from one to the other can be accomplished quickly and economically in the field.

THOUSANDS OF C/C METERING PUMPS now in operation have proven their abilities under the most severe operating conditions in the chemical processing, petro-chemical, water and waste treatment and paper and pulp industries.

Write today for detailed information on the proven Clark-Cooper CC Pump line . . . the only *complete* line in precision liquid metering.

*(*either plunger or diaphragm type*)

THE EXCLUSIVE CLARK-COOPER LIQUID-END DESIGN



Exclusive drop-out check valve construction of Clark-Cooper pumps provides easy disassembly for inspection and maintenance.

Valve units are stacked in the straight column liquid end and are easily accessible when threaded end plugs are removed. Units are self-aligning and interchangeable for fast, simple reassembly.

CLARK-COOPER DIVISION

FREDERIC B. STEVENS, INC.

Palmyra, (Burlington County) New Jersey

Representatives in All Principal Cities

ASK PHILADELPHIA!

Gas/liquid mixes may demand extra-generous freeboard for expansion during absorption. Ask Philadelphia. Certain balky chemical reactions can be speeded by proper mixing. Philadelphia can tell you for sure. Carefully positioned multiple impellers are often needed to suspend rapidly settling solids. Philadelphia engineers will help you to the right design.

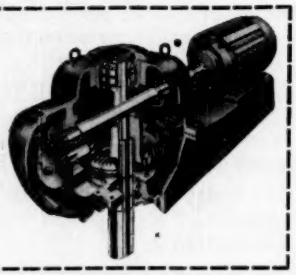
Whatever your process, Philadelphia engineers have the *know-how* to help you mix effectively. And Philadelphia's laboratory and research staff has the *find-out* you need for new applications.

Good General Rule: when you buy mixers, talk to men who *know* how torque is delivered for thorough mixing.

Best General Rule: ask Philadelphia about mixers *and* mixing. Philadelphia Mixers do what they're sold to do. Philadelphia Mixers *mix*.

Get Facts—and plenty of them—on mixer design, construction, and specification. Sections on *Fluid Mixing Practice* and *Process Mixing Technology* detail steps you can take to improve process efficiency. Read how *you* can custom-design mixers to fit your own space requirements. Request 64-page Bulletin A-19 on your letterhead today.

HERE'S THE SECRET of trouble-free mixing: gears precision-ground to master gear perfection. Tougher, quieter, more powerful—the best mixer drives made are made by Philadelphia.



PHILADELPHIA MIXER

DIVISION OF PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania

ASK ANY ENGINEER / GEARS ARE THE HEART OF A MIXER

AGMA MEMBER

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U.S.I. CHEMICAL NEWS

May ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1961

New Method for Detecting And Analyzing Chemicals & Gases Uses Radioactivity

A new technique for super-sensitive detection and analysis of chemicals and gases, by reacting them with a radioactive compound, is covered in a patent issued recently. Called "radiometric exchange," the basic principle is said to have great potential in air pollution studies, atmospheric and outer space measurements, and industrial process control.

Techniques evolving from the new method are reported to offer several advantages over previously existing techniques:

(1) extreme sensitivity, with accuracy in the parts per billion range.
(2) continuous monitoring and analysis for long periods without attendants.
(3) simplicity and compactness.
(4) selectivity.
(5) detection of wide range of compounds.

In a typical case—air pollution studies—the principle has been applied to the measurement of sulfur dioxide in the atmosphere by drawing the air through a small reaction cell. Sulfur dioxide in the air reacts in the cell to form a radioactive gas. The amount of radioactive gas generated is directly proportional to the amount of sulfur dioxide in the air. By counting the radioactivity present with a geiger counter, direct determination of sulfur dioxide is made.

Methionine Seems to Play Role in Reducing Cholesterol Deposition

Studies at a Chicago hospital have correlated influences of dietary patterns on cholesterol formation and artery disease incidence. The research was carried out on poultry and confirms previous observations on monkeys and rats.

In the tests, restricted intake of methionine by chicks on a high-cholesterol, high-fat diet resulted in increased deposition of cholesterol. There was also increased coronary and aorta atherosclerosis. High-protein, high-vitamin supplementation tended to suppress these conditions. High protein feeding alone seemed to reduce coronary atherosclerosis only. High vitamin feeding alone had no effect. The type of protein fed also appeared to be a factor. Soy protein gave better results than casein- gelatin.

Banner Year for Fertilizers Expected in 1961

Greater Capacity for Sulfuric Acid, Phosphoric Acid, and Phosphates Will Couple with Trend to High Analysis Fertilizers. Gross Tonnage Unchanged but Dollar Volume Will Be Up.

The Business and Defense Services Administration, U.S. Department of Commerce, predicts that the 1961 fertilizer season will be slightly better than the 1960 season. Dollar volume of all chemical fertilizers shipped in 1960 is estimated at $1.220 billion, $40 million higher than 1959. Dollar volume is expected to increase again in 1961. Gross 1961 tonnage, however, is expected to remain unchanged at the 25.3-million ton level of 1960 because of the shift to higher analysis fertilizers.

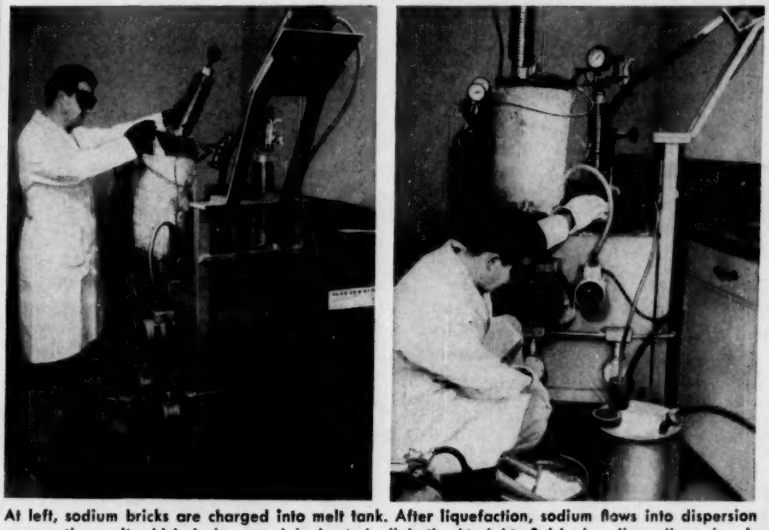
Ammonia and Sulfuric Production Up

For November 1960, the Census Bureau reported synthetic ammonia production at 408,035 short tons; ammonium nitrate fertilizer grade production at 259,948 short tons; nitrogen solutions production, including combinations with urea, at 63,326 short tons. All figures were up from November 1959. This trend is expected to continue through the heavy spring selling season.

The Business and Defense Services Administration expects a 2.5-million ton increase in sulfuric acid production for 1961. About 1.5 million short tons of acid ca-

MORE

3-Gallon Sodium Dispersion Unit Loaned Out by U.S.I. for Eighth Straight Year



At left, sodium bricks are charged into melt tank. After liquefaction, sodium flows into dispersion preparation unit which is immersed in heated oil bath. At right, finished sodium dispersion is transferred by low pressure nitrogen into metal storage vessel.

This equipment was designed and built by U.S.I. in 1953, as an aid to companies investigating sodium dispersions on a pilot plant scale. It has been out on loan ever since—for 30-day periods—in plants from coast to coast.

This unit has been employed to prepare sodium dispersions for many types of reactions. Among them are included: Claisen condensations; Wurtz type reactions; sodium alcoholate preparations; purifications; sodium alkyl and aryl preparations; metalations; sodium hydride preparations; acidic hydrogen replacements; polymerizations.

If you are interested in borrowing this unit, please contact Manager, U.S.I. Sodium Sales, U.S. Industrial Chemicals Co., 99 Park Ave.. New York 16, N. Y.

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

May ★ **U.S.I. CHEMICAL NEWS** ★ 1961

New Sedative Derived from Reserpine Acts Rapidly

A potent, fast-acting sedative has recently been derived from the drug reserpine. It is reported to achieve its calming effect within 30 minutes.

According to the results of tests to date, the compound does not appear to lower blood pressure, accumulate in the body, cause nasal stuffiness, or increase intestinal motility. These are all undesirable side effects of reserpine. The material also appears to be unusually potent in suppressing fibrillatory spasms of the heart.

The new sedative is identified as 18-epi-O-methylresperate hydrochloride. The same synthetic method used to prepare the new compound has been used to produce additional compounds, it is reported. Some are said to have sedative action while others seem to show the anti-fibrillatory effect.

New Bulletin on FILMEX® Solvent for Flexographic Inks Published by U.S.I.

A new bulletin on FILMEX special industrial solvent is now available from U.S.I. This bulletin gives properties, specifications, shipping data, uses.

FILMEX is U.S.I.'s trade-marked ethyl alcohol special industrial solvent formulated to meet the needs of the graphic arts and photographic industries. Since FILMEX does not contain ethyl acetate or hydrocarbons as denaturants, it has no adverse effects on rubber plates, rolls and type used in flexographic printing.

FILMEX is also used for drying photographic film. After film has been developed, fixed, washed and rinsed in FILMEX, it dries in minutes and does not curl.

Copies of this new FILMEX bulletin can be obtained by addressing the Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., New York 16, N. Y.

CONTINUED

Fertilizers

pacity is being added this year in the form of new plants. Most of the output of these new facilities will go for manufacture of wet-process phosphoric acid and superphosphates. Total capacity by the end of 1961—25 million tons.

Change Due in Phosphate Use Pattern

Marketable phosphate rock output in the United States is estimated by the Bureau of Mines at 17.4 million long tons in 1960, 10% more than was produced in 1959. The Bureau reports that several expansions in phosphate production facilities in Florida are scheduled for completion this year.

Spokesmen for the Tennessee Valley Authority, another federal agency deeply concerned with fertilizers, expect that the trend to higher analysis materials will result in increased use of concentrated superphosphates, ammonium phosphates, phosphoric acid and other high analysis phosphates. Use of normal superphosphates is expected to decrease. A new 54% concentrated superphosphate has been developed which uses "superphosphoric" acid. The latter material is produced by a new TVA process.

Another new development reported by TVA is ammonium polyphosphate, with a typical analysis of 15-62-0. It can be used in solid mixed fertilizers, and is also said to be storable in solid form for quick conversion to liquid fertilizer as needed.

U.S.I.'s fertilizer raw materials production is centered at the company's Tuscola, Illinois, plant. A new ammonia storage tank designed to assure rapid delivery of ammonia, aqua ammonia, and nitrogen solutions during the fertilizer season has just been completed. U.S.I. also produces sulfuric acid for fertilizers at Dubuque, Iowa; De Soto, Kansas; and at Tuscola.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Isophthaloyl and terephthaloyl chlorides now offered in semi-commercial quantities. Suggested as intermediates in polymer preparations and in organic synthesis for pharmaceuticals, dyes, etc. Available as high-purity flakes. **No. 1710**

New recorder said to expedite gas chromatography by charting peaks and areas simultaneously. Automatically integrates area while chromatogram is being recorded. Accuracy claimed to be ±0.5% full scale. **No. 1711**

N-Methyl acetamide—colorless, crystalline organic intermediate of 98.5+% purity, with melting point of about 28°C.—now available in semi-commercial quantities. **No. 1712**

Safety guide covering emergency organization in chemical plants can now be purchased at nominal price. Pamphlet stresses responsibility of management in developing and administering emergency plans; recommends procedures. **No. 1713**

New general-purpose laboratory shaking bath is claimed to be largest capacity standard shaking bath available with longest adjustable stroke. Designed to provide both continuous agitation and controlled temperatures. **No. 1714**

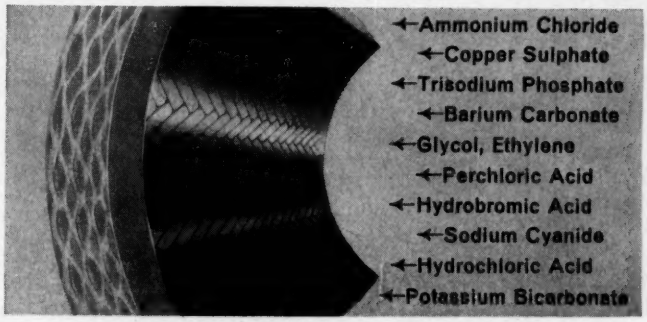
Carbobenzoxy chloride of 99.5-100% purity now on market. Said to be stable preparation which can be used and stored with minimum hazard. Ordinary potency is maintained so that in acylating, reaction is more complete. **No. 1715**

First issue of Journal of Theoretical Biology was released recently. New international periodical will publish original papers on generalized theories, theories of specific processes or phenomena, theoretical discussions of specific projects or methods, and the like. **No. 1716**

New flow meter features removable flow tube for convenient sterilization. Used to measure flows of pharmaceuticals, film emulsions, food ingredients and other conductive materials requiring accurate, sanitary measurement. **No. 1717**

Molecular models now offered are made of styrofoam. Scale: 1½ in. per angstrom. Color scale distinguishes ionic, covalent, polar bonds. Sizes of atoms proportional to partial charge. **No. 1718**

First high performance, commercial atomic absorption spectrometer for trace metal analysis has been developed. Designed with great flexibility to enable researchers to explore potential applications of atomic absorption and to point the way to future instrumentation. **No. 1719**

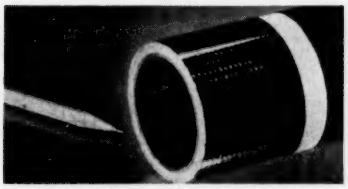


CORROSION-RESISTANT TO CHEMICAL ATTACK—Fibercast has outstanding ability to withstand corrosive chemicals and gases. Its unique construction provides many advantages. Fibercast is a centrifugally cast thermoset epoxy resin reinforced pipe with multiple layers of glass fibers embedded and bonded by heat to provide chemical resistance, high strength and long service life.

Remarkable Fibercast pipe safely handles 94% of known corrosive solutions

- *Copes with temperature range from −65° to +300° F*
- *Withstands operating pressure range to 1200 psi*
- *Handles 320 of the 338 most corrosive solutions*
- *Available in pipe sizes from 2″ to 8″ with fittings*

You see above the dramatic ability of Fibercast pipe to "live with" punishing chemicals without ill effects—without trace of corrosion or scale.

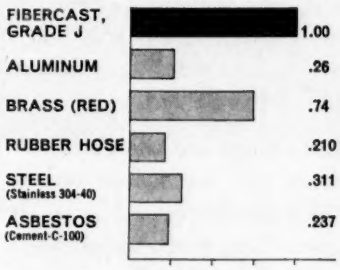


Fibercast has built-in inhibitors you can depend on to combat corrosion, contamination, scaling, electrolytic action. It is capable of withstanding sudden temperature differentials from cool liquids to hot gases or steam. It's good for all operating pressure ranges to 1200 psi.

Fibercast's lightweight means substantial savings in installation costs. No painting or maintenance is necessary.

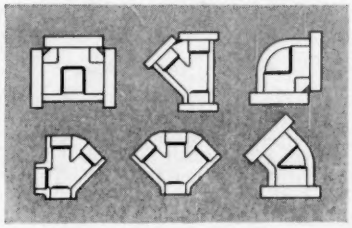
The inner walls are ceramic-smooth, discouraging build-up of scale or deposits to clog or jam the system, saving downtime, replacement and repair. The Hazen-Williams C Flow Factor of Fibercast is 147.

COMPARATIVE LIFE DATA*



*Basing Fibercast as unit life of 1 and others as comparative percentages thereof.

The combination of benefits inherent in Fibercast are not found in any other kind of pipe: aluminum, brass, steel, stainless, asbestos, rubber, glass, plastic. Fibercast offers exciting new possibilities to solve the processing problems of your plant. It is resistant to most liquid and gaseous industrial chemicals and products, liquid foodstuffs and other difficult materials.



Fibercast is now available in sizes from 2″ to 8″ with the world's most complete stock of couplings and fittings. For more detailed information, mail coupon.

FIBERCAST COMPANY CE-51
Box 727, Sand Springs, Oklahoma
Please send me, without obligation, further details about Fibercast Tube and Pipe.

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FIBERCAST® COMPANY
A DIVISION OF **Youngstown** SHEET AND TUBE COMPANY

Alemite Accumite® Centralized Lubrication System avoids costly breakdowns, work-stoppage. Automatic positive lubrication protects all machines!

The Alemite Accumite® Centralized Lubrication System comes complete with pump, metering valves and controls. Meters exact amount of lubricant to all bearings whenever system is operated by air, vacuum or manually at any predetermined frequency.

There's no need for a lubrication shutdown. No chance of work spoilage or bearing failure due to over lubrication. The Alemite Accumite System accurately meters .003, .006 or .009 cu. in. shots of oil or grease automatically. Is available with adjustable fittings for applications requiring measured metering from .003 cu. in. to zero. "Snap-On" and "Screw-In" type valves make for complete flexibility in converting existing systems to automatic operation.

You are assured economical, trouble-free operation of equipment. All bearings are sealed against dirt, grit and water. You are able to eliminate the dangers of neglect because all bearings receive proper lubricant in one, automatic, safe operation!

For complete details on Alemite Accumite® Centralized Lubrication Systems for large or small, stationary and mobile equipment (Canning and Labeling Machines • Tractor Trailers and Lift Trucks • Farm Implements • Machine Tools • Textile Machines • Any Machine or Vehicle with Moving Parts) write for your *FREE* Alemite Accumite Catalog . . . today!

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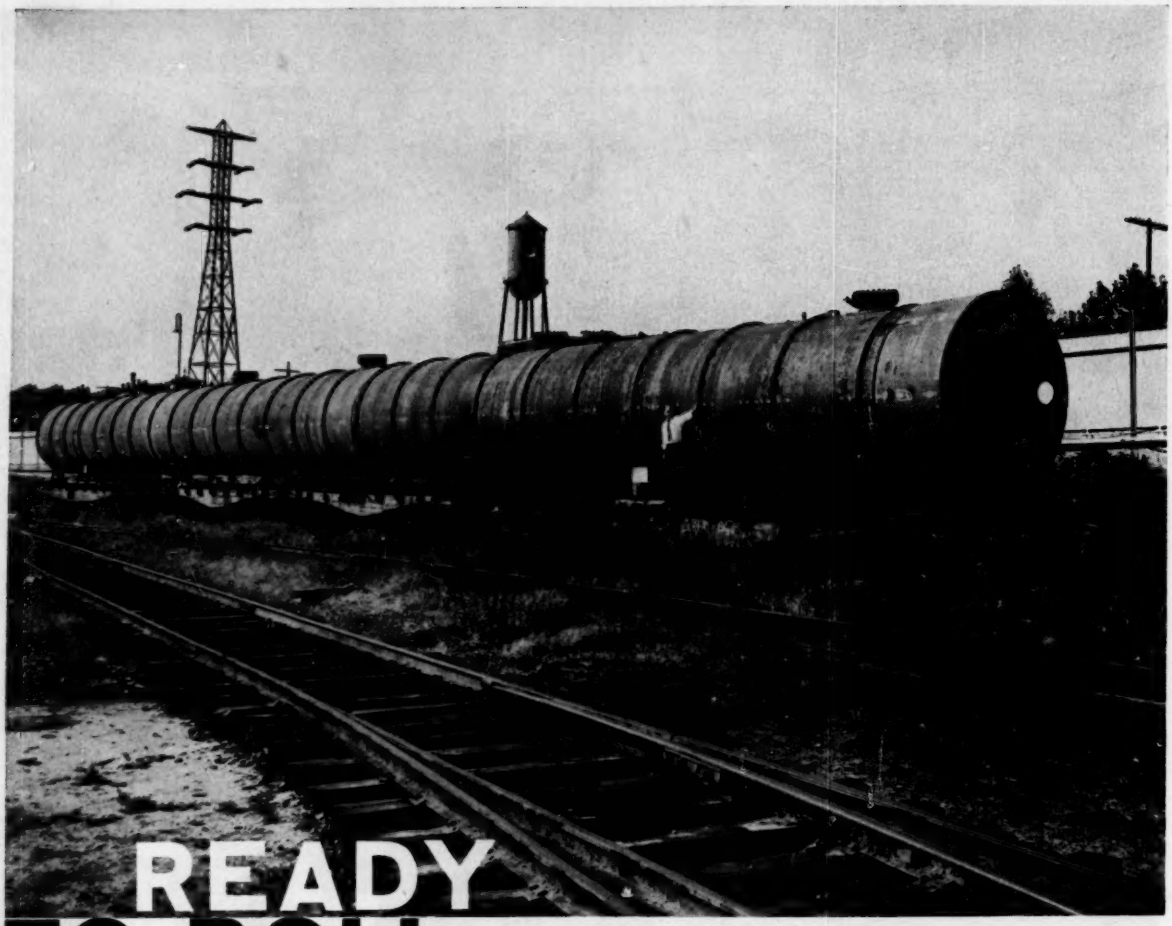
STEWART-WARNER CORPORATION

1850 Diversey Parkway, Chicago, Illinois



READY TO ROLL . . .

Another big tower for industry

Building and delivering big items like the 165-foot-long fractionating tower pictured here is routine performance at Sun Ship. Two towers, each weighing 135 tons and identical with that shown above, were constructed for a petrochemical plant for processing petroleum gases. They were shipped on 9 flatcars. Railroad officials said it was one of the largest shipments ever moved by rail. Because of its length the shipment had to travel a circuitous rail route.

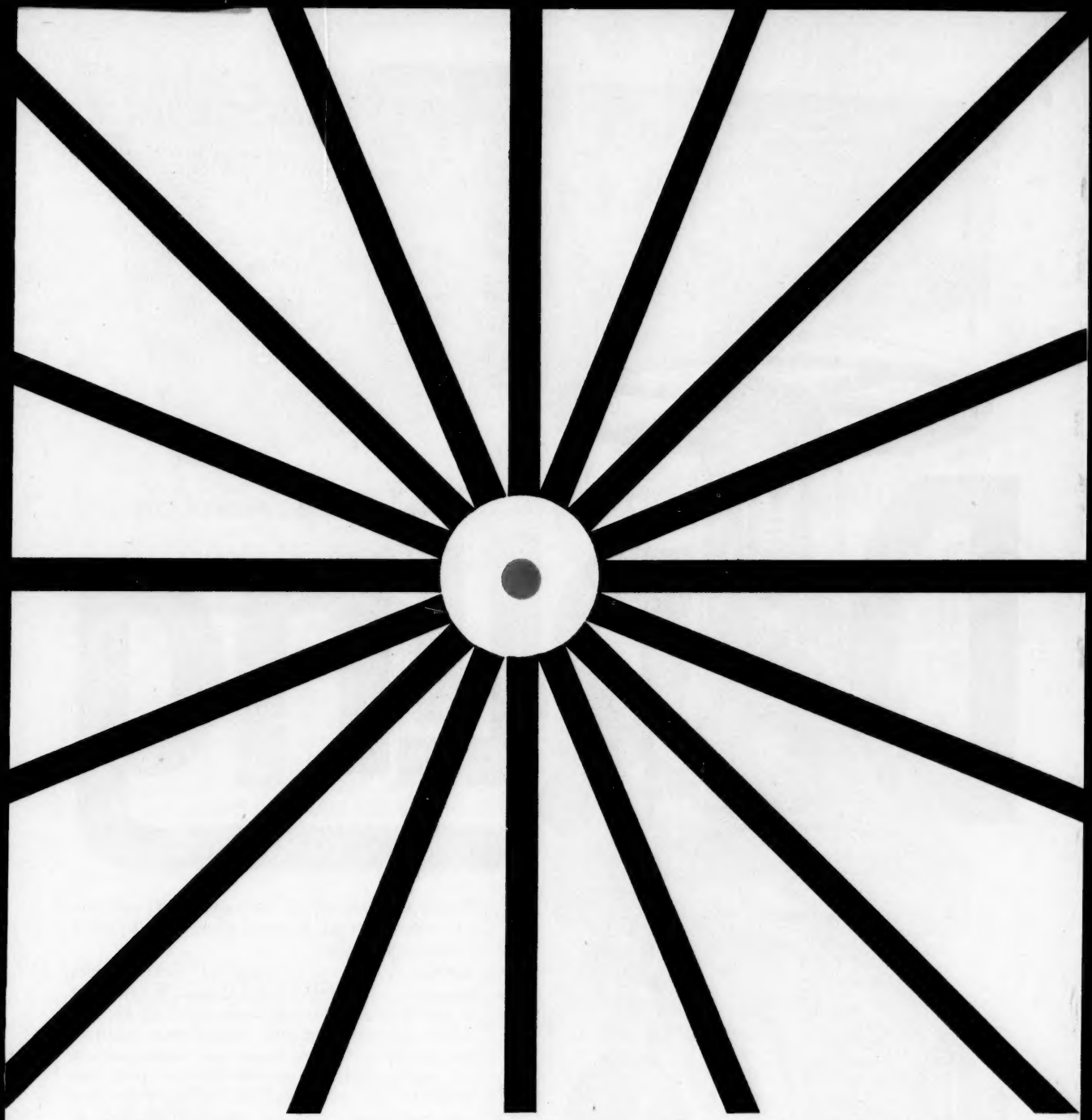
Whether it's a massive fractionating tower or intricate equipment, your requirements will be met with exacting precision and your product delivered on schedule by rail or water from our tidewater plant.

Sun Ship's modern fabricating and engineering services put these advantages at your fingertips. For full information, call or write our Sales Engineering Department.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.



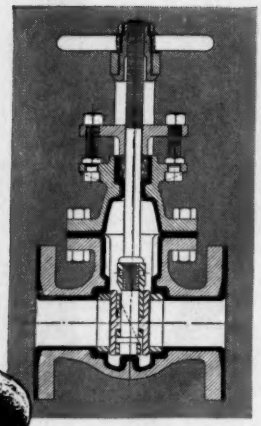
Hagan reports on Pressure Control

Dealing with full scale pressures ranging from 6,000 psi to .2" water is routine with Hagan. Maintaining the desired conditions within 0.1% of full scale is equally routine. Hagan has instrumentation and final control elements that can handle compressors, exhausters and valves from tiny laboratory equipment to the 10-ton giants used in wind tunnels. Packaged to handle corrosive atmospheres and Division One area requirements, they are extremely easy to maintain and troubleshoot.

At one installation where valve position may change as much as 30°, a Hagan pressure control system is holding pressure within ±0.5% of full scale . . . despite the fact that air flow changes from 0 to 600 lb/sec in less than 5 seconds. This system is made up of standard Hagan components, demonstrating the range and accuracy of the equipment.

Measuring and regulating all the variables that enter into process control is a part of Hagan's forty years of experience in the design and manufacture of instrumentation and control elements. Designed for a high degree of reliability and accuracy, Hagan components are also versatile in application; a very desirable characteristic in relation to inventory and stocking problems. For more information on the complete Hagan line of electronic, pneumatic and hydraulic controls, write or telephone HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Pittsburgh 30, Pa. Phone WAlnut 2-3737.

HAGAN



Darling rubber-lined (heavy lines) iron body gate valves with special alloy working parts provide trouble-free operation in many corrosive and abrasive services.

YOU CAN DEPEND ON

Darling

Darling rubber-lined iron body gate valves eliminate the need for expensive special alloy valves in many different applications.

The hard rubber lining on bodies and bonnets provides high resistance to corrosion and abrasion in services up to 180° F. and working pressures up to 150 lbs. The revolving double disc parallel seat and wedge construction minimizes friction, avoids wear concentrations, and automatically compensates for any valve seat deflection. *You can depend on Darling* rubber-lined iron body gate valves for maximum efficiency at minimum cost.

Darling rubber-lined iron body gate valves in rising stem, cylinder or motor operated, and quick-opening types, as well as rubber-lined iron body check valves, are available in sizes from 2″ to 24″. Write, wire or phone for bulletins.

DARLING VALVE & MANUFACTURING COMPANY

Williamsport 3, Pa.

Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

TRADE DARLING MARK

GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

100,000,000 lbs. of POLYOLEFINS PER YEAR WILL BE PRODUCED BY 10 CONTINUOUS PROCESSING LINES NOW BEING BUILT BY BAKER PERKINS

Now all the well known advantages of continuous processing have been adapted by Baker Perkins to compounding polyolefins and other plastics. The operation of each B-P processing line is fully continuous from the feeding of the polymers, pigments, stabilizers and other additives to the discharge of the dried pellets ready for bagging. Each line includes a Force Feeder, *a Ko-Kneader (List System) Continuous Mixer, *a Cross-Head Extruder, *a Hot-Cutting Unit, Water Cooling Trough, Dewatering Conveyor and *Heating and Cooling Unit for the Ko-Kneader and Extruder. Individual lines are designed for 750, 1800, or 3500 pounds per hour.

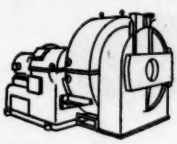
*These units are shown in top photograph.

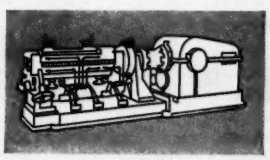
ADVANTAGES OF B-P CONTINUOUS PLASTICS PROCESSING SYSTEM

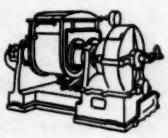
- Improved Product Quality
- Maximum Operating Flexibility—
  Coloring, compounding, venting, modifying, blending and homogenizing can all be accomplished in the same machinery without any alteration.
- Lower Installed Cost—
  Single floor installation
  Uniform power loads minimize electrical wiring requirements.
- Reduced Operating Costs
- Low Maintenance Costs

Modern equipment and skilled operators produce the precision components of Baker Perkins plastics processing lines. The operator in the photo above is machining a Ko-Kneader screw on one of the many special purpose machine tools in Baker Perkins shops. Extruder screws are also machined on this same machine. Exacting quality control is maintained in all manufacturing operations at Baker Perkins.

BAKER PERKINS INC.







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With ONE-COTE CEMENT

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Right! **5 BAGS OF ONE-COTE WILL COVER AS MUCH AREA AS 6 BAGS OF ORDINARY INSULATING-FINISHING CEMENT!**

Eagle-Picher ONE-COTE goes on in one single coat to the desired thickness . . . *does three jobs*—all in one quick and easy application . . . insulates . . . protects . . . finishes. Saves time, work and money! Effective for temperatures up to 1000 F.

For outdoor installations, Eagle-Picher One-Cote is quick-setting, withstands rain and moisture two hours after application. Contains a special rust-inhibitor to prevent rust. When used indoors, One-Cote requires no wire mesh or finishing treatment!

Eagle-Picher produces a line of industrial insulations for all temperatures from below zero to over 2000 F. See our complete catalog in Sweet's Plant Engineering File or write for descriptive material.

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'BUFFALO' PRESSURE BLOWERS

FOR THESE INDUSTRIES

Chemical
Steel
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Rugged, ribbed and gas-tight, 'Buffalo' Type CB Pressure Blowers are serving with distinction on a wide variety of applications. Wheels are narrow, heavy-duty steel plate construction, plug welded, riveted or continuously welded for high strength under high pressure service. Housing scroll is continuously welded. Inlet and outlet are flanged. Inlet and scroll are mastic sealed. Special construction is available for high-temperatures, corrosive or explosive atmospheres. Capacities to 37,500 cfm and pressure to 74" w. g. Also a line of Type R High Pressure Blowers for specialized requirements—details on request. Write for Bulletin FI-310.

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canada Pumps Ltd., Kitchener, Ontario

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

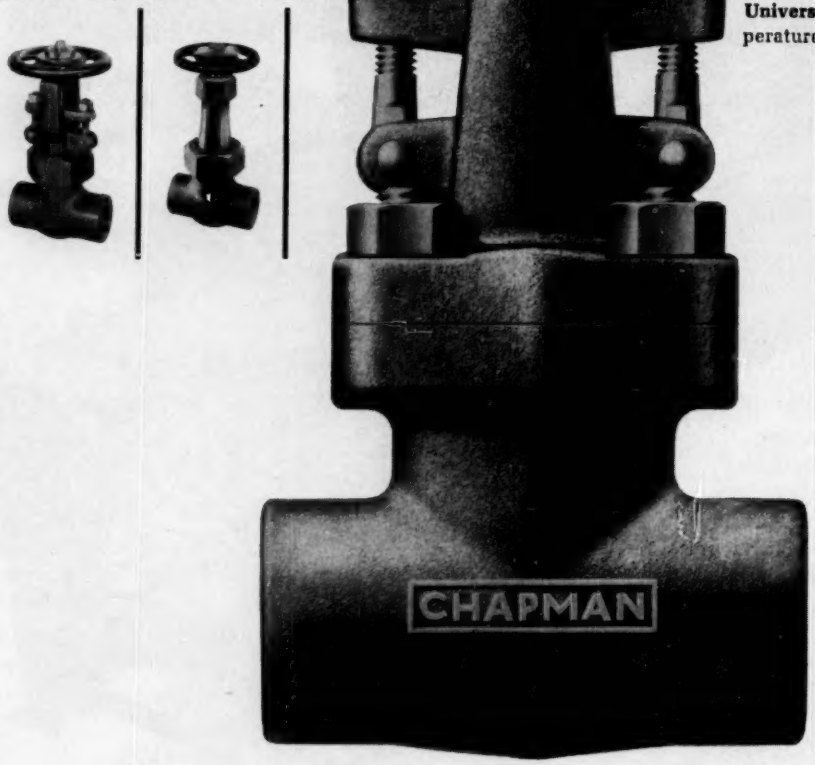
Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

ENGINEERED TO "TAKE CARE OF ITSELF"...

In valves, "forgetability" is a true measure of worth. "Forgetability" is defined in terms of those qualities which allow a valve, once installed, to be almost forgotten. It results from perfection of performance, and year-after-year dependability; combined with less than moderate maintenance requirements. These characteristics are the outgrowth of knowledgeable design and excellence of materials... both are tradition with Chapman Valves.

Product of an all-inclusive development program by Chapman, the *originators* of forged steel gate valves, the 960B represents the integrity in design, thoughtful selection of materials, and pride in workmanship which have made their name synonymous with quality valves since 1875.

New Chapman 960B Rugged-Duty Forged Steel Gate Valve



Wheel... cast ductile iron. **Stem**... heat-treated stainless steel; backseats in bonnet. **Yoke Sleeve**... corrosion resistant Chapman alloy CV510. **Follower and Gland**... socket and ball type: bind-proof follower; stainless steel gland. **Eyebolts**... stainless steel; swing-down design. **Yoke**... "bowlegged" design for exceptional hand room. **Stuffing Box**... bigger, with special, heavy-duty packing **Bonnet and Body**... forged carbon steel. **Male-Female Joint**... for precise alignment; makes gasket blowout impossible. **Gasket**... asbestos filled, spiral-wound, flexible stainless steel ribbon. **Disc-Stem Connection**... sliding joint prevents load transfer. **Disc**... hardened stainless steel; guided travel. **Seat Rings**... shoulder type, Stellite-faced stainless steel. **Universal Trim**... all standard services; temperatures to 1000°F; pressures to 2000 psi.

PRESSURES TO 2000 PSI ☐ TEMPERATURES TO 1000 F ☐ SIZES ¼ TO 2 IN. ☐ UNIVERSAL TRIM FOR ALL SERVICES

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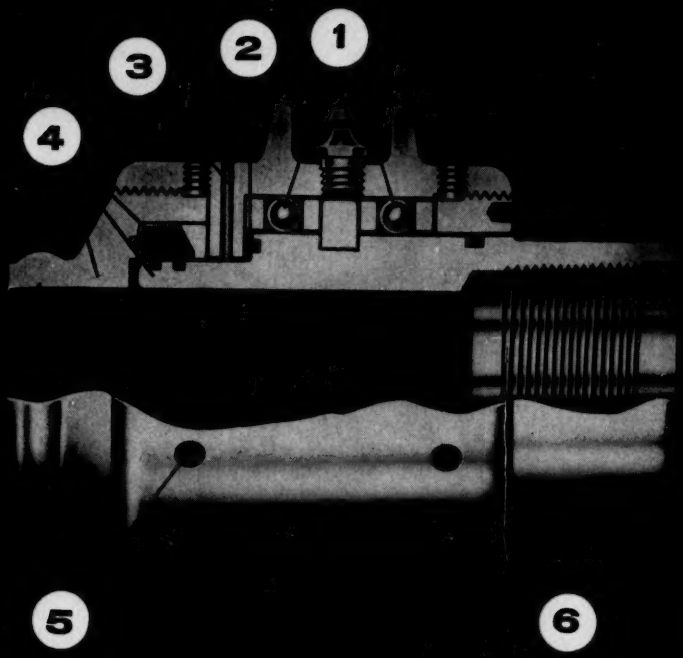
MANUFACTURING COMPANY ■ INDIAN ORCHARD, MASSACHUSETTS ■ A SUBSIDIARY OF CRANE CO.



1.
2.
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6.

US TYPE SWIVEL JOINTS

..handle corrosive chemicals

..stop grease contamination of fluids

..are repaired on location with simple tools

..can be welded into the line

Continental-Emsco US Type swivel joints are designed *exclusively* for the chemical industry. Fluid contacts metal and packing only, so wettable parts of corrosion resisting stainless steel (or other alloys) can handle all types of caustic products. Primary Teflon packing, *deformed* into grooves for a tight seal, and a secondary asbestos seal prevent grease from contaminating products. Packing chamber design is patented. It reduces bearing wear by preventing packing from pressing against bearings, and allows free swiveling regardless of internal pressure. Joints break like a union without unseating ball bearings and other parts. Joint can be welded into the line, eliminating costly flanges. Threaded and flanged ends are also available. Wide bearing spacing through use of solid bearing races insures accurate alignment and provides maximum bearing support for internal and external loadings. Races are separate and can be reversed to double their life. Repairs and adjustments are made on the spot, without special tools .. shop or factory equipment not required.

Save installation and maintenance costs by designing, building or replacing with Continental-Emsco swivel joints. There's a size and type to meet all your product handling problems. Let us bid on your next requirement.

New Swivel Joint Catalog Now Available .. Write for it Today.

CONTINENTAL-EMSCO
Industrial Products Division
P. O. Box 359, DALLAS 21, TEXAS

A Division of The Youngstown Sheet and Tube Company

CONTINENTAL-EMSCO COMPANY • P. O. Box 359 • Dallas 21, Texas

Gentlemen: Please send me your current Swivel Joint Catalog. We are planning:
( ) New installation ( ) Replacement ( ) Catalog File

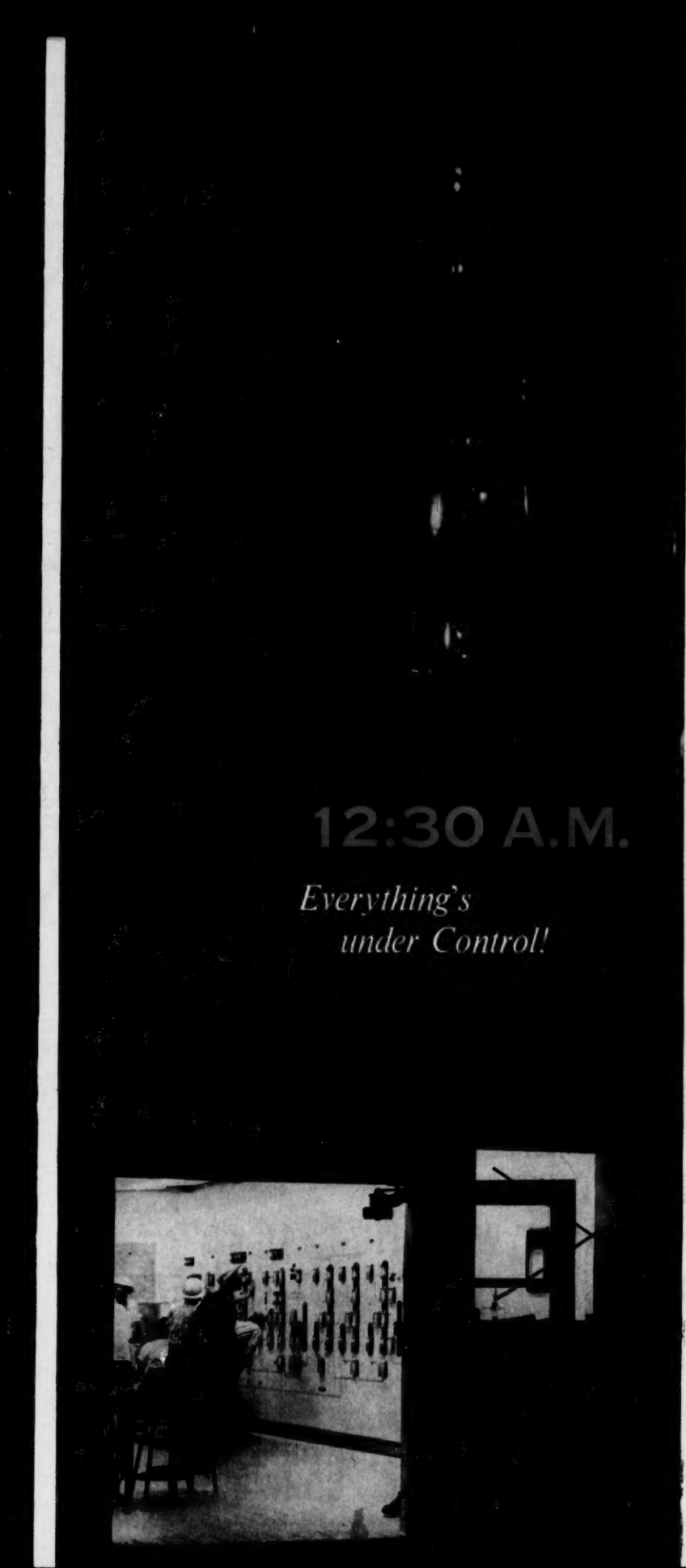
NAME _____ TITLE _____

COMPANY _____

CITY _____ ZONE _____ STATE _____

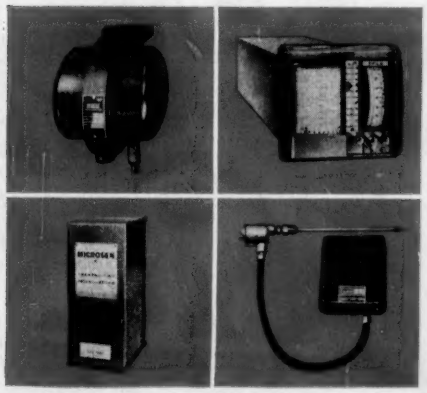
PLEASE PRINT

SJ902



ROBERTSHAW
MICROSEN

All's right at half after midnight.
The new shift settles in to monitor the processing steps. Meanwhile, out among the towers, Robertshaw-Microsen® Electronic Systems are providing maximum automation for data acquisition, transmission, recording and control of process variables. It's a typical job for Robertshaw—keeping everything under control. For greater system flexibility, lower initial investment and minimum operating costs—specify Robertshaw-Microsen for precision control of pressure, temperature, differential pressure, oxygen concentration, liquid level, gas analysis, pH, flow. Over 50 sales-service offices—write for address of the one nearest you—and for Technical Bulletin 10, entitled "Process Instrumentation."



Shown above: (Top, l. to r.) Microsen Transmitter, Microsen Recording Controller. (Bottom) Microsen Transmitting Potentiometer, Level-Tek Level Detection and Control System.

Robertshaw
CONTROLS

Aeronautical and Instrument Division
Robertshaw-Fulton Controls Company,
Santa Ana Freeway at Euclid Avenue
Anaheim, California

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½' x 11' x 8' PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

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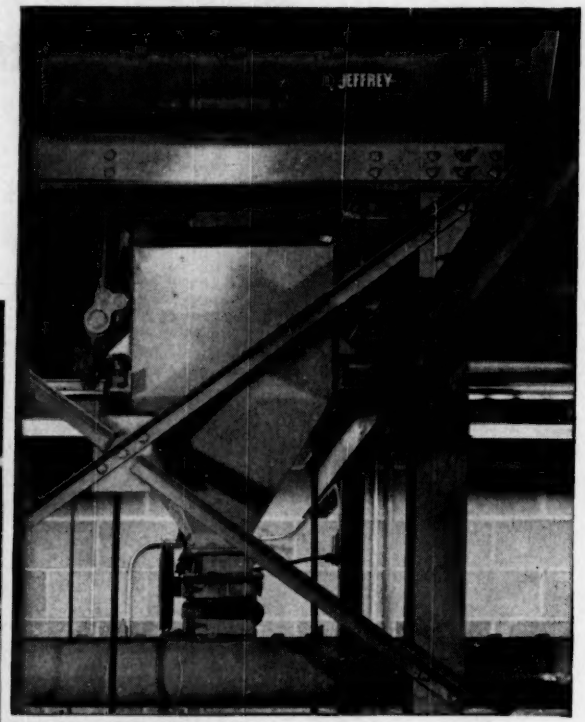
Jeffrey system eliminates manual handling of lead oxide at Universal Battery plant

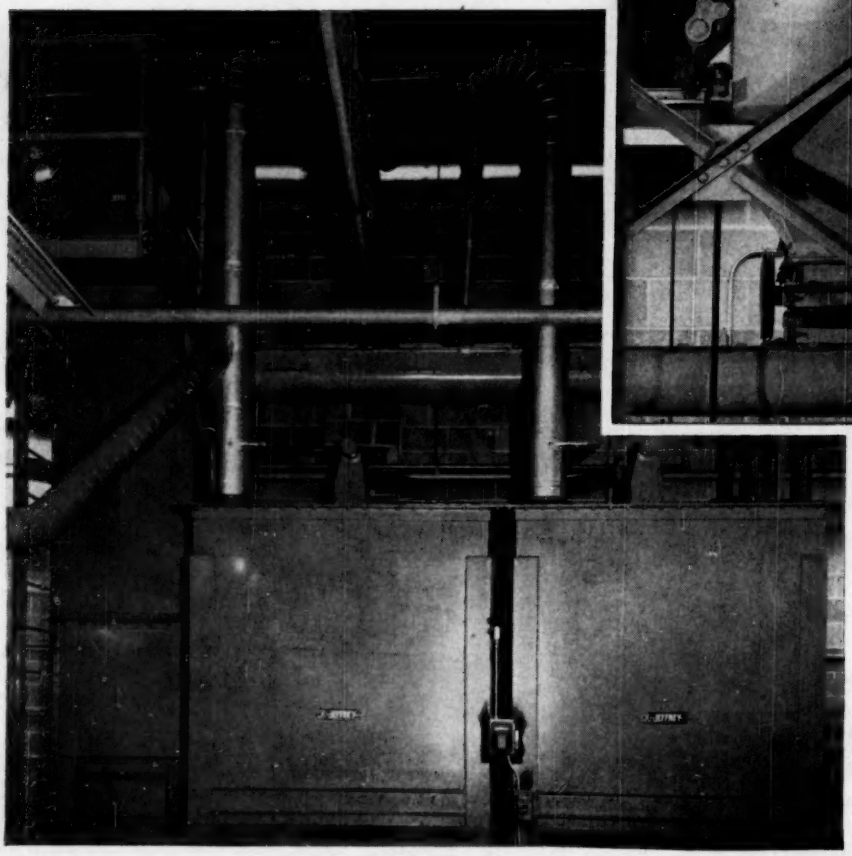
Tank trucks deliver lead oxide to Universal Battery Company's new plant in Chicago, where it is transferred to storage by air. No more back-straining handling of 600-pound drums. The Jeffrey system of storing, elevating, weigh blending and conveying has eliminated all manual handling in these operations.

Jeffrey furnished this equipment: the storage tank for the lead oxide, a bucket elevator to lift it to the spiral conveyor that feeds the Jeffrey weigh bin, and two rotary vane feeders. From tank truck to Simpson mixer, push button-control takes care of every phase of the system.

Planned by A. Epstein & Sons Inc. of Chicago, this installation combines that engineering firm's materials handling know-how and the proven dependability of Jeffrey products. The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.



From this Jeffrey weigh bin, batches are delivered to the Simpson mixer by the Jeffrey spiral conveyor.



Jeffrey bucket elevator lifts lead oxide to the spiral conveyor feeding the Jeffrey weigh bin.

If it's conveyed, processed or mined, it's a job for JEFFREY

Kimax Tempered Glass Pipe never affects your product.

Made rugged for amazing resistance

One of the many benefits of Kimax Tempered Glass Pipe is its ruggedness. Selective tempering and one-piece construction give an unusual degree of mechanical strength and resistance to normal abuse.

Yet this pipe is light in weight for easy handling and installation.

It has amazing heat resistance —operating in temperatures up to 450°F. It shrugs off heat shock to permit quick transition from hot to cool flow, speeding cleaning and reducing down time.

Smooth inner walls of Kimax Tempered Glass Pipe prevent scaling and corrosion. Since glass is inert, nothing is added or taken from the products flowing through this pipe . . . total assurance of constant product purity.

Transparency permits a rapid, visual check for stoppages. When clogging occurs, cleaning is quickly and easily done since every joint is easily disassembled.

Light-weight, durable, and economical Kimax Tempered Glass Pipe is available with complete fittings and accessories for every piping requirement, and is interchangeable with other piping.

For your free copy of the current catalog, write to Kimble Glass Company, subsidiary of Owens-Illinois, Toledo 1, Ohio.

Distributed in the U.S. and Canada by Fischer & Porter Company, Warminster, Pa.

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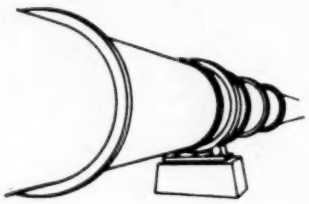
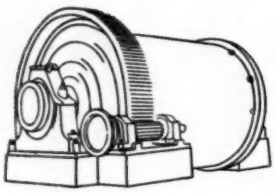
TRAYLOR EQUIPMENT

for the mining and process industries

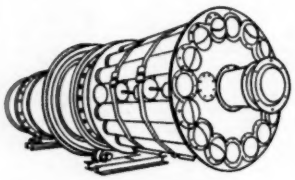


TRAYLOR ROTARY KILNS AND SLAKERS . . . the excellence of design and engineering of Traylor kilns is a result of over 58 years' experience in the manufacture of specialized machinery for the mining and process industries. Kiln shells are automatically welded of heavy steel plate. Alignment is maintained by easily adjusted supports. Full-floating type riding rings are of forged or cast steel, mounted on machined pads. Steel main gears and pinions are machined on a special gear generator. Kilns are designed and engineered to meet your specifications. Traylor has the most extensive research facility now available in the industry to insure delivery of process-perfected equipment to you.

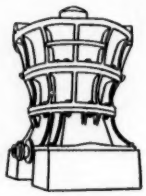


TRAYLOR BALL AND COMPARTMENT MILLS . . . **BALL MILLS** in both overflow and diaphram discharge types have shells of welded steel with detachable heads of cast steel.

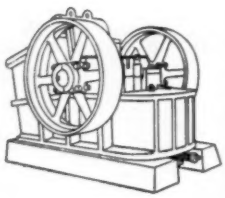
COMPARTMENT MILLS . . . partitioned by slotted diaphrams, these mills allow progressive reduction of product as it passes through different grades of grinding media within the mill, thereby reducing the amount of handling necessary in product reduction.



TRAYLOR COOLERS AND DRYERS . . . manufactured in diaphram and multiple tube design, receive the same care in design and construction as Traylor kilns. Dryers are either air cooled or water cooled or both and are available with direct or indirect firing, designed to your capacities or specification.



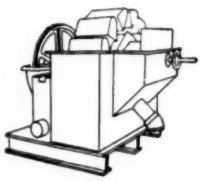
TRAYLOR GYRATORY CRUSHERS . . . Traylor is world famous as the manufacturer of giant 60″ gyratory crushers, secondary reduction crushers and fine reduction crushers. Crushers are designed with Traylor's original non-choking, self-tightening bell heads and curved concaves for large tonnage of small product and uniform size with a low percentage of waste and fines. Power applied as a direct crushing force offers greatly reduced power requirements at every setting.

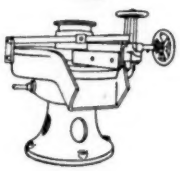


TRAYLOR JAW CRUSHERS . . . feature the original curved jaw plates for greater capacities at finer settings and longer life of the wearing plates. The swing jaw is made of cast steel of extra heavy design and the pitman shaft is of annealed open hearth forged steel, for lightness with great strength. Maintainence and inspection are simplified by the design which makes all parts readily accessible.

TRAYLOR SLURRY FEEDERS AND TABLE FEEDERS . . . **SLURRY FEEDERS** are self contained, fully closed ferris wheel type feeders . . . accurately supply a constant volume of slurry to kilns and mills. Single welded tank and hopper units are available in sizes from 36″ to 84″.

TABLE FEEDERS . . . accurately regulate the flow of material to mills, kilns and dryers. The revolving table receives material at its center from an adjustable feed spout. Feeders available from 2′ to 10′ in diameter.





See Chemical Engineering Catalog for details and specifications.

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HOKE **Flow Sheet** 5

HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise – lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction – 360° rotatable housing – operates in any position.

We make them of forged brass or stainless steel, in ⅛" and ¼" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

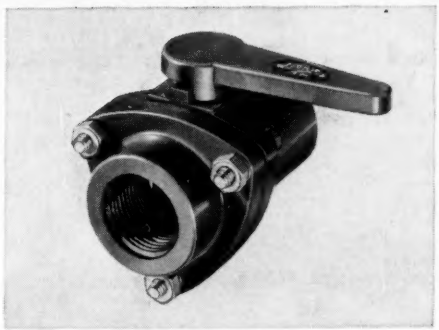
Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

There's only one way to get conclusive performance proof – buy a valve. Ask for Bulletin SV-4-61.

A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.



Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination – they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.

Size-wise, we're offering them in ½, ¾, 1, 1½, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

'61 PRODUCT PARADE

You'd be surprised at some of the screwball ways our valves have been used (to decided advantage, of course). Hoke distributors are armed to their maxillary third molars with this method madness and will redesign your systems (incorporating solenoid valves and PVC ball valves) at the drop of a postcard. Check the PRODUCT PARADE box.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

HOKE, INCORPORATED
39 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

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- ☐ Solenoid Valves
- ☐ Product Parade
- ☐ Flow Sheet
- ☐ Complete Catalog GC960

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SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

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- **PRESSURES:** to 21 psi in single stage pumps; to 70 psi in multi-stage types
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- **MOTORS:** standard motors for 115/230-volts 60 cycles 1 phase (other electrical characteristics available). Power range from ⅛ to 1½ H.P.
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- **DRIVES:** all models available in belt or coupling drive with ball-bearing equipped stands. Space-saving close-coupled pumps most rugged and popular — but many pedestal models also available
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- **INSTALLATIONS:** a wide range of transfer, recirculation, feed, boost, and filter-pumping applications

TO FIND OUT: write for the brand-new Centrifugal Pump Catalog — Bulletin 130. Here are all the models — including useful engineering data.

For a complete review of positive displacement pumps for non-lubricating fluids, write for Bulletin 220. Eastern Bulletin 400 is your guide to a broad line of midget-centrifugal pumps and stirrers for the laboratory.

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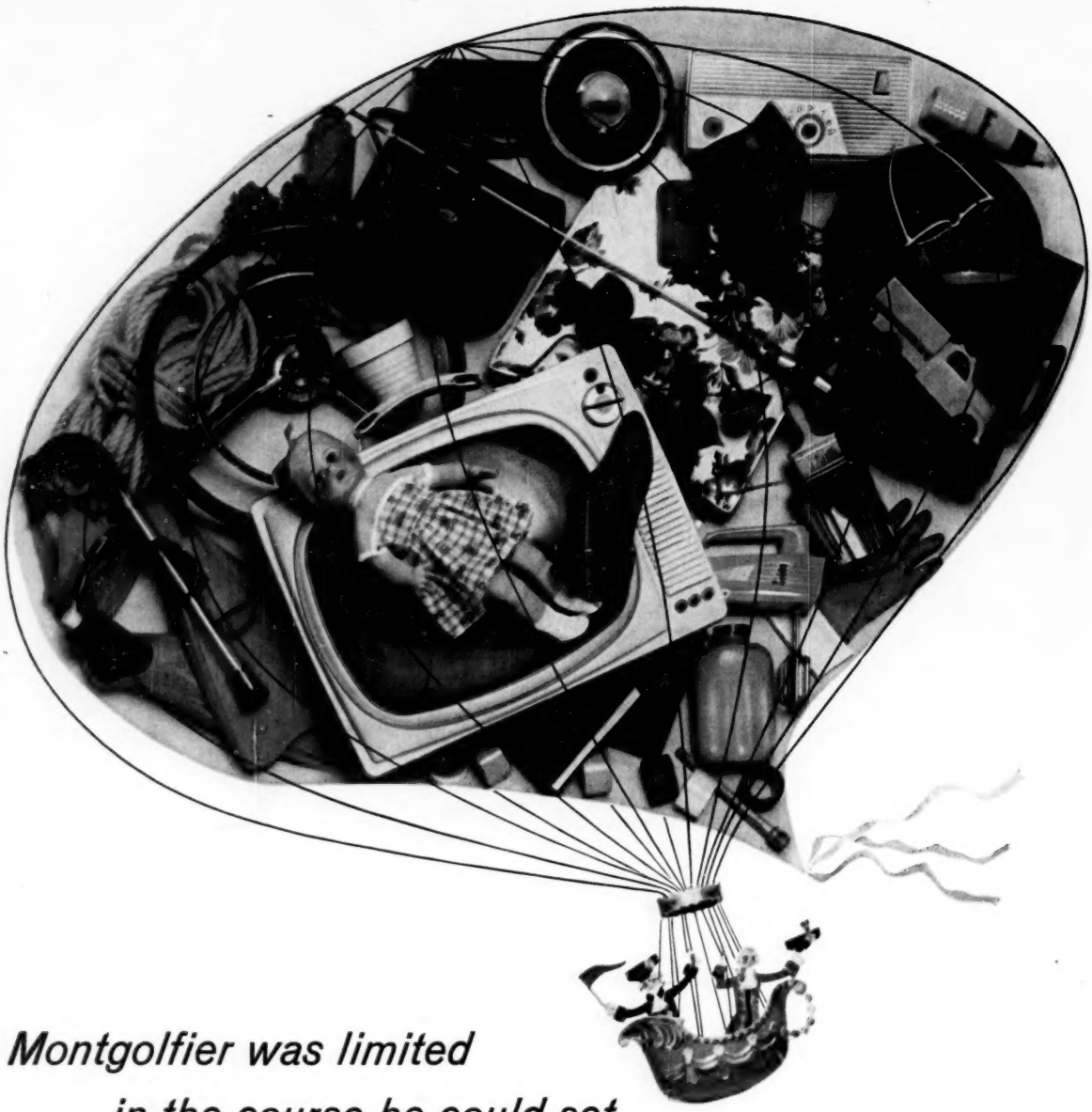

Montgolfier was limited in the course he could set...

The inventor of the first fire balloon couldn't control his direction. But with Sinclair petrochemicals, you can set a sure course toward the development of new and profitable products.

For example, Durene, C_{18} Olefins, Iso-octenyl Alcohol and Iso-octenyl Chloride are just a few of the latest products from Sinclair petrochemical research that make possible new plastics, detergents, plasticizers and herbicides, plus a great number of additional products and applications.

You benefit in other ways, too – because the quality of Sinclair petrochemicals has *always* been *above* customers' specifications. What's more, Sinclair production schedules are set up to assure you of product supplies when and as you need them.

Why not take advantage of this record of performance. It costs no more for the best! Just call or write...

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Subsidiary of Sinclair Oil Corporation, 600 Fifth Avenue, New York 20, N. Y.

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Top news stories and what they mean to CPI technical decision-makers

Chementator

Are prospects brightening for organic chemicals from wood?

Though many doubt that wood will ever become a major source of synthetic organic chemicals, Crown Zellerbach Corp. is betting increasing amounts of money that silvichemicals will make good.

The firm recently brought a plant on stream at Bogalusa, La., to make dimethyl sulfoxide from kraft liquor. Now, Crown has taken an option on exclusive American and Canadian rights to a lignin hydrogenation process developed by Japan's Noguchi Institute. The route converts byproducts from either kraft or sulfite pulping into phenolic compounds and neutral oils. Noguchi has operated a small pilot plant for two years, is now planning a 2,200-lb./day plant in Tokyo.

Briefly, process consists of taking dry lignin and grinding it with neutral oil recycle to form a paste. The lignin slurry, along with 0.5% of an unidentified catalyst, is hydrogenated at 200-250 atm. and 700 F. for about one hour. Conversion of lignin to liquids is close to 100%.

Product oil is filtered to remove solids and then is distilled and solvent-extracted. Among the products are paracresol, 4-ethyl-phenol, 4-propyl-phenol, catechols, neutral oil and heavy oil. Phenolic fraction is about 50% of total yield.

The heavy oil fraction, less than 15% of the product, boils above 500 F. Part of it is used to make the lignin paste and the rest is cracked to form hydrogen for the hydrogenation step.

Secret catalyst and polymerization process make polyolefin latexes

Spencer Chemical is building a 20-million-lb./yr. plant at Calumet City, Ill., to produce an entirely new form of polyethylene—a latex.

Behind this development lies a novel polymerization process—the details of which Spencer is keeping to itself. Key is an unidentified catalyst that allows the polymerization to take place on a specially prepared latex starter. Spencer won't say whether the material is added as ethylene or a low-molecular-weight polymer.

This technique differs from other methods that solubilize PE for surface coatings, such as that developed by Delka Research Corp. (*Chementator*, Sept. 5, 1960, p. 43). That process depends on oxidizing the polyethylene chain into shorter segments, forming essentially long-chain alcohols.

Spencer's process takes the opposite approach, builds a latex-length molecule (believed to have a molecular weight around 30,000) from shorter segments. The latex resin product is said to have the properties of "almost pure" polyethylene. Spencer plans to use this same technique to make latexes from other polymers that previously could not be solubilized.

Spencer's PE latex, called Poly-Em, is expected to find its major outlet in polish formulations, textile treating and paper coating.

Polymethylbenzenes find first use; commercial status believed near

As construction proceeds on Amoco Chemicals' multimillion-lb./yr. trimellitic anhydride plant at Joliet, Ill., observers are watching to see what effect it will have on a new family of aromatic chemicals: the polymethylbenzenes.

Feedstock for this pioneer trimellitic plant will be pseudocumene (1,2,4-trimethylbenzene). The unit, which will come on stream late this summer, is being built by Scientific Design Co. and will utilize the Amoco oxidation process. This is a liquid-phase, air-oxidation route using bromine and a heavy metal as catalyst.

Pseudocumene is oxidized first to trimellitic acid, then is dehydrated to form the anhydride. The trifunctional character of the anhydride is said to give it unique advantages for making alkyd resins. It is being offered by Amoco at an introductory price of $1/lb.

Enjay Chemical is one firm with an

Why, indeed? As long as you're in a hydrogen area, there's just as much danger of explosion with one piece of equipment as there is with the other.

And the same goes for acetylene areas, too. *And* for all other pieces of electrical equipment in such an area . . . fixture hangers, seals, flexible couplings, junctions, push button stations.

Crouse-Hinds is the only single source for complete systems of UL-listed explosion-proof electrical equipment, no matter what the National Electrical Code Class or Group.

Crouse-Hinds is also your prime source for expert assistance in choosing and applying equipment for hazardous areas. A Crouse-Hinds Field Engineer is always available to help you plan complete protection in flammable atmospheres of gases, vapors or dusts.

Call your Crouse-Hinds Distributor while you're still in the planning stage of building or remodeling. *That's* the time he can really save you money!

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active interest in Amoco's project. Enjay has been producing developmental quantities of polymethylbenzenes at parent Humble Oil's Baton Rouge, La., refinery. Informed sources believe that Enjay will be supplying Amoco's pseudocumene needs.

Enjay's polymethylbenzenes are a byproduct of catalytic reforming. Aromatics are extracted from the reformate, then fractionated. A sidestream of C_9 and C_{10} aromatics can be superfractionated to give pseudocumene. Similar techniques yield other trimethyl- and tetramethylbenzenes.

None of these materials is yet commercial, but the success of trimellitic anhydride would assure volume markets for at least one of them.

Confirming earlier speculation (Chementator, Apr. 3, p. 81), Nalco Chemical says that it is "considering" building a 26-million-lb./yr. plant to make TEL and TML gasoline additives. Unit would be located on the Gulf Coast and employ an electrolytic process developed by Nalco.

Natural gas process for coking western coals will go commercial

Conversion of low-grade western bituminous coal into coke neared commercial reality with the announcement that U. S. Smelting Refining & Mining Co. and Victor Chemical Div. of Stauffer Chemical Co. are jointly erecting a coking unit at U. S. Smelting's lead-zinc flotation mill near Salt Lake City. Victor's electric phosphorus furnaces at Silver Bow, Mont., will consume a substantial amount of the coke.

To convert "noncoking" western coals to usable coke requires considerably more processing than is accomplished in ordinary byproduct coke ovens. U. S. Smelting starts with coal fines, pelletizes them with water and an inert binder. Dried pellets, preheated to about 570 F., feed into a coking retort. Natural gas, blown up through the retort, decomposes at 2,200 F., to furnish carbon that combines with the volatile matter given off by the coal. If natural gas did not provide carbon, a portion of the pellets themselves would be consumed, making the coke product friable.

Products from the operation include hard coke pellets under an inch in diameter with less than 1% volatile matter; hydrogen-rich off-gas; and up to 50 gal. of byproduct oil and tar from each ton of coal. (Disposition of the gas and liquid products was not revealed.) About 8,000 cu. ft. of natural gas are consumed in the reactor to produce a ton of coke; additional gas is used to heat the reactor and preheater.

Another process for coking western coals is being developed by Food Machinery & Chemical Corp. and U. S. Steel. Reportedly, coal is first devolatilized to produce a friable semicoke, then briquetted and coked. No results have been announced since the pilot plant started operation at Kemmerer, Wyo., last August, but spokesmen say the unit is "very active."

Peak pressure is raised 50 psi. for natural gas reforming process

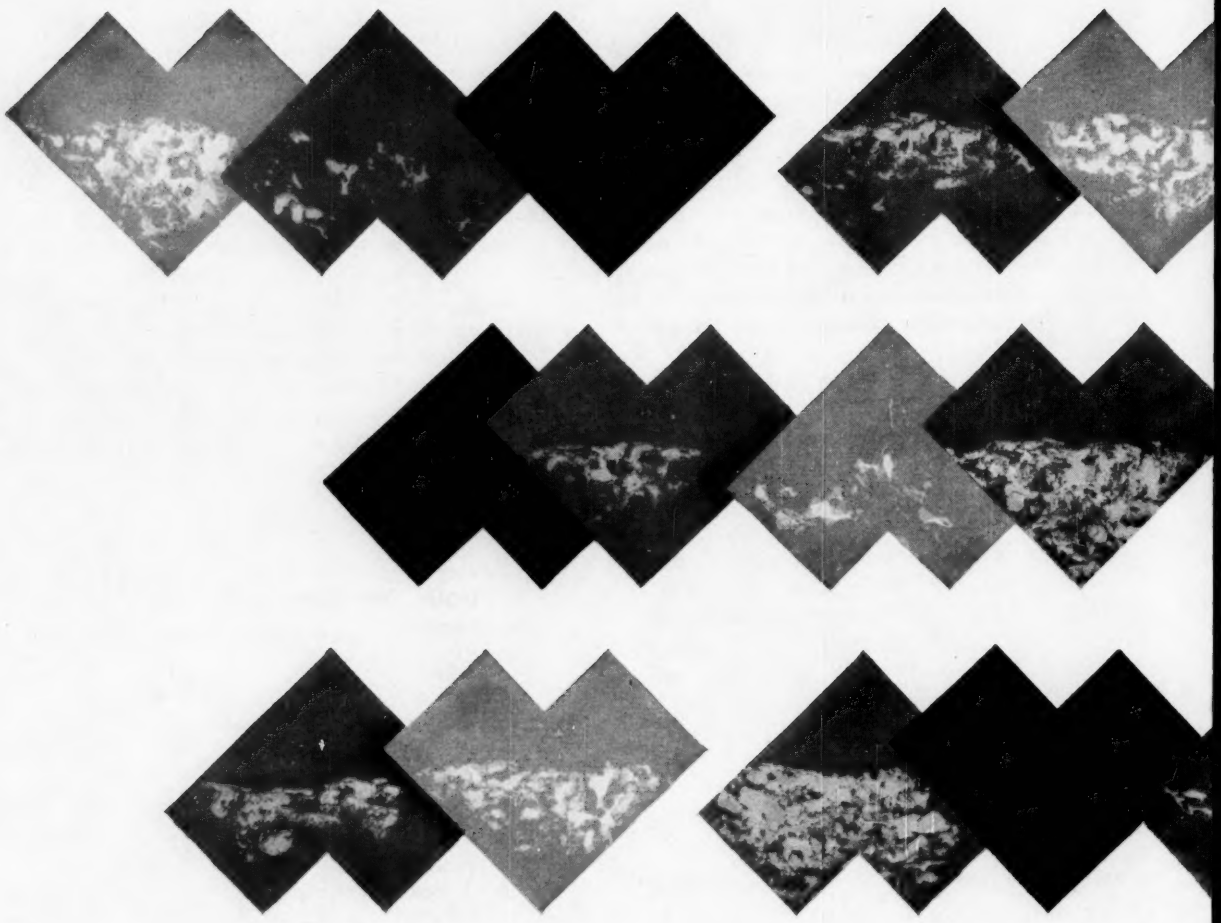
Foster Wheeler Corp. has just declared itself among the advocates of high pressure for the steam reforming of natural gas. The 60,000-ton/yr. ammonia plant that the company will build for W. R. Grace at Big Spring, Tex., will employ a reforming pressure "higher than any plant in the U. S." According to trade sources, it will probably be around 300 psig.

This move by Foster Wheeler reinforces a trend advanced by Chemical Construction Corp., which has built reforming furnaces to operate at 250 psig. (*Chem. Eng.*, Apr. 17, pp. 158–161). Among the advantages of high pressure for reforming are: (1) savings in cost of compressing the reformed gas for charging to ammonia synthesis unit; (2) greater heat recovery as high-pressure steam. It's estimated that the higher pressure will save $2/ton in ammonia manufacturing costs.

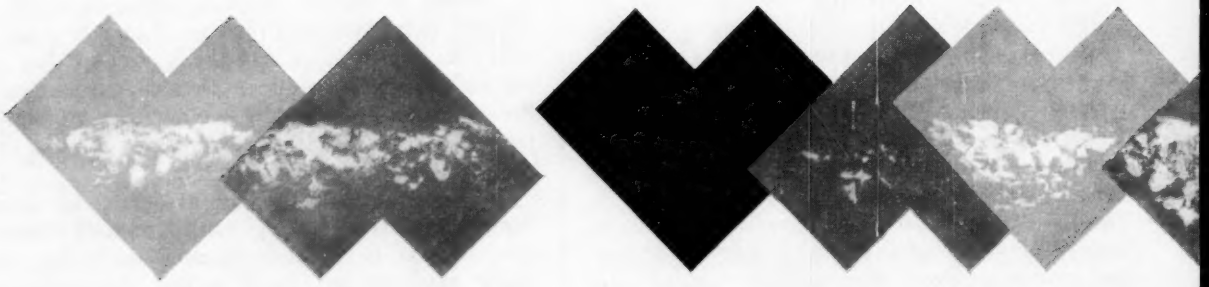
Going to higher pressure will require few changes in its standard furnace, Foster Wheeler tells *CE*. The furnace will use all-radiant heating, with a vertical-tube, terrace-wall design. Special devices include a unique way of supporting the tubes, and techniques to assure uniform heat distribution.

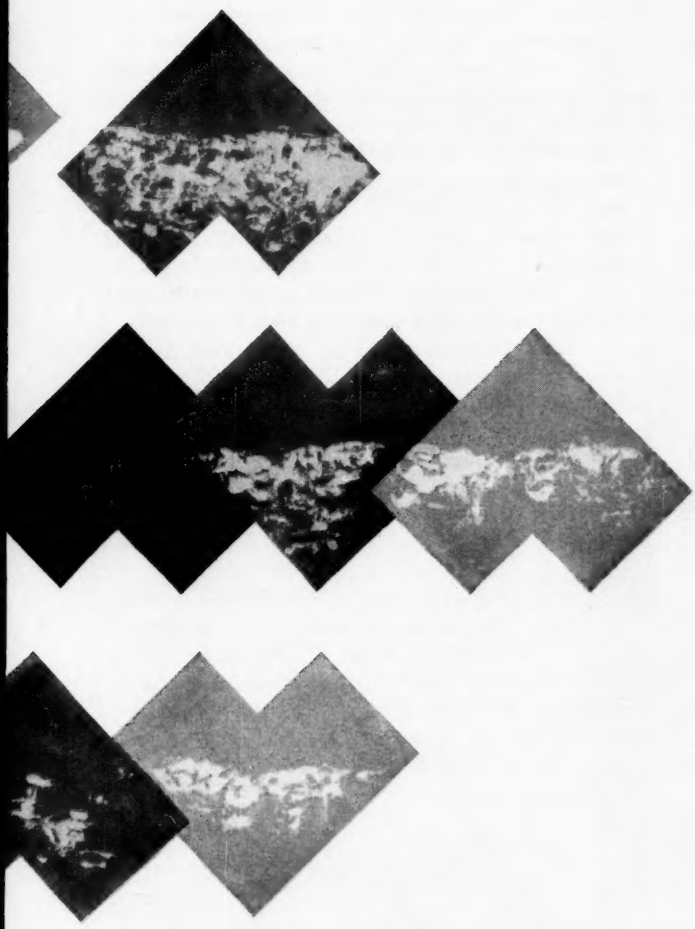
Tubes to be used, which are of a standard high-temperature alloy, have already been checked out in another furnace operating at lower pressure but much higher temperature than the proposed steam reforming application.

(Continued on page 62)

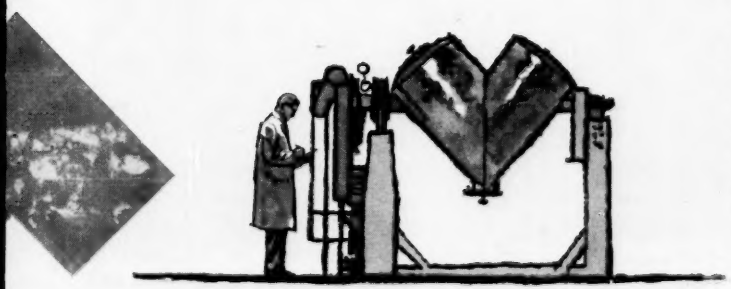


new P-K solids-processor* performs up to 10





SOLIDS PROCESSING OPERATIONS



1. *Gentle precision blending*
2. *Intensive blending*
3. *Liquid-solids blending*
4. *Granulation of solids*
5. *Vacuum drying of solids*
6. *Coating of solids*
7. *Heat sterilization of solids*
8. *Gas sterilization of solids*
9. *Chemical reaction of solids*
10. *Heating or cooling of solids*

(Many of these operations can be performed under vacuum)

The P-K Solids Processor offers new economies in quality control, equipment, time, manpower, space. For the first time it combines vacuum drying and liquid-solids blending in one fully packaged unit, performing more operations than ever before possible.

DRY BLENDING – With this latest P-K "Twin-Shell" development you can tumble solids to give gentle precision blending. This may be done under vacuum or atmospheric conditions, in inert or sterilizing gas, with heat in jacket up to 200°F., or with cooling through jacketed shell. If required, intensifier bar action breaks up agglomerates or gives uniform dispersion of difficult materials such as pigments.

LIQUID DISPERSION, GRANULATING – You can disperse controlled amounts of liquid uniformly into solids. Fluids of any viscosity can be handled.

Dispersion can be sufficiently intimate to provide a lump-free powder. Or you can regulate it to produce granulations of controlled size. As in dry blending, you can conduct these steps under vacuum or atmospheric conditions, in inert or sterilizing gas, or with cooling or heating through jacketed shell.

VACUUM DRYING – You can use the P-K Solids-Processor to vacuum dry heat sensitive materials. A separately actuated agitator speeds drying to a finished fine powder or controlled granule. In final stages of drying, direct hot air or gas can be introduced.

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*Patented and Patents Pending

Patterson Kelley

Chemical and Process Equipment Division
125 Burson Street, East Stroudsburg, Pa.

So the total stress in the new high-pressure furnace will be no greater than the proved capability of the tubes, says Foster Wheeler.

The Grace plant will use amine scrubbing in the CO_2-removal section. All steam needed for stripping will be generated by waste heat from the furnace, which is designed to operate at an over-all fuel economy of 86%. If needed, the plant could also export 0.5 ton of 50-psig. steam for every ton of ammonia produced.

Broadening its stake in the polyolefins field, W. R. Grace has just obtained an exclusive license to market polypropylene produced by Montecatini's subsidiary, Novamont Corp., at Neal, W. Va. Arrangement is similar to that between Spencer Chemical and polypropylene-producing Enjay Chemical.

Molecular sieves strive to win role in natural gas sweetening

Molecular sieves (synthetic zeolites), which have gained wide acceptance in gas drying and liquid sweetening, are now aiming at an elusive but potentially lucrative market: natural gas sweetening.

Advantages of small on-site adsorption sweetening plants, point out sieve-producers Linde Co. and Davison Chemical, are simplicity of operation and reduction of pipeline corrosion. (Conventional amine scrubbing plants are quite complex, and a single unit must serve many gas wells in order to be economical.) However, several technical problems have prevented sieves from winning any backers to date.

It's a different story in liquid sweetening, where sieves now desulfurize (from 400-500 ppm. down to 5 ppm.) 50% of all propane produced. And Gulf Oil and Warren Petroleum recently announced successful development of an adsorption process for sweetening natural gasoline containing several thousand ppm. sulfur.

Natural gas sweetening is a bigger problem, however, because of complications in sieve regeneration. Usual way to remove adsorbed sulfur compounds is to pass hot natural gas through the bed, then flare the whole stream. Because of the smaller volume of fluid handled, the amount of gas needed for regeneration of liquid-hydrocarbon sweeteners is not significant. In a natural gas sweetening plant, however, if 5-10% of the gas has to be flared in order to regenerate the bed, the cost becomes prohibitive.

Linde Co. has been working on natural gas sweetening for over three years, has worked with Maloney-Crawford Tank & Mfg. Co. on an experimental unit in West Texas. That first plant had some mechanical problems, but Linde says that it now has evolved a sweetening plant design that is both practical and economical.

Last full-scale test of adsorption for gas sweetening was conducted by Sage Oil Co. near Edmonton, Alta. But it had to be stopped recently after a few months' operation because oil started flowing along with the gas. The unit is now being moved to another well.

First domestic user of the Stora-Kaldo basic oxygen steelmaking process (Chementator, Aug. 8, 1960, p. 58) will be Sharon Steel Corp. It is building a $17.5-million plant at its Roemer Works in Farrell, Pa., that will incorporate two of the rotating S-K refining furnaces.

Company turns to new flotation process to hike beryl output

Another firm is probably going to beat Beryllium Resources to commercialization of the latter's Van Dornick beryl flotation process. Standard Beryllium Corp., New York, has announced that it is negotiating for use of the route at its Boa Vista beryl mine in Brazil.

Standard Beryllium expects to be producing 2,500 tons/yr. beryl concentrate via the flotation process by year's end. Present plans call for construction of a second 2,500-ton/yr. mill after the first plant is tested out. Beryllium Resources hopes to have its own flotation mill at Delta, Utah, operating early in 1962.

Standard Beryllium plans to take advantage of what it sees as a 250% jump in beryl consumption in the next two years. Up to 30,000 tons/yr. of beryl are expected to be used in 1962; 12,000 tons each for Brush Beryllium and Beryllium Corp., and 6,000 tons for England's Imperial Smelting. *(Continued)*

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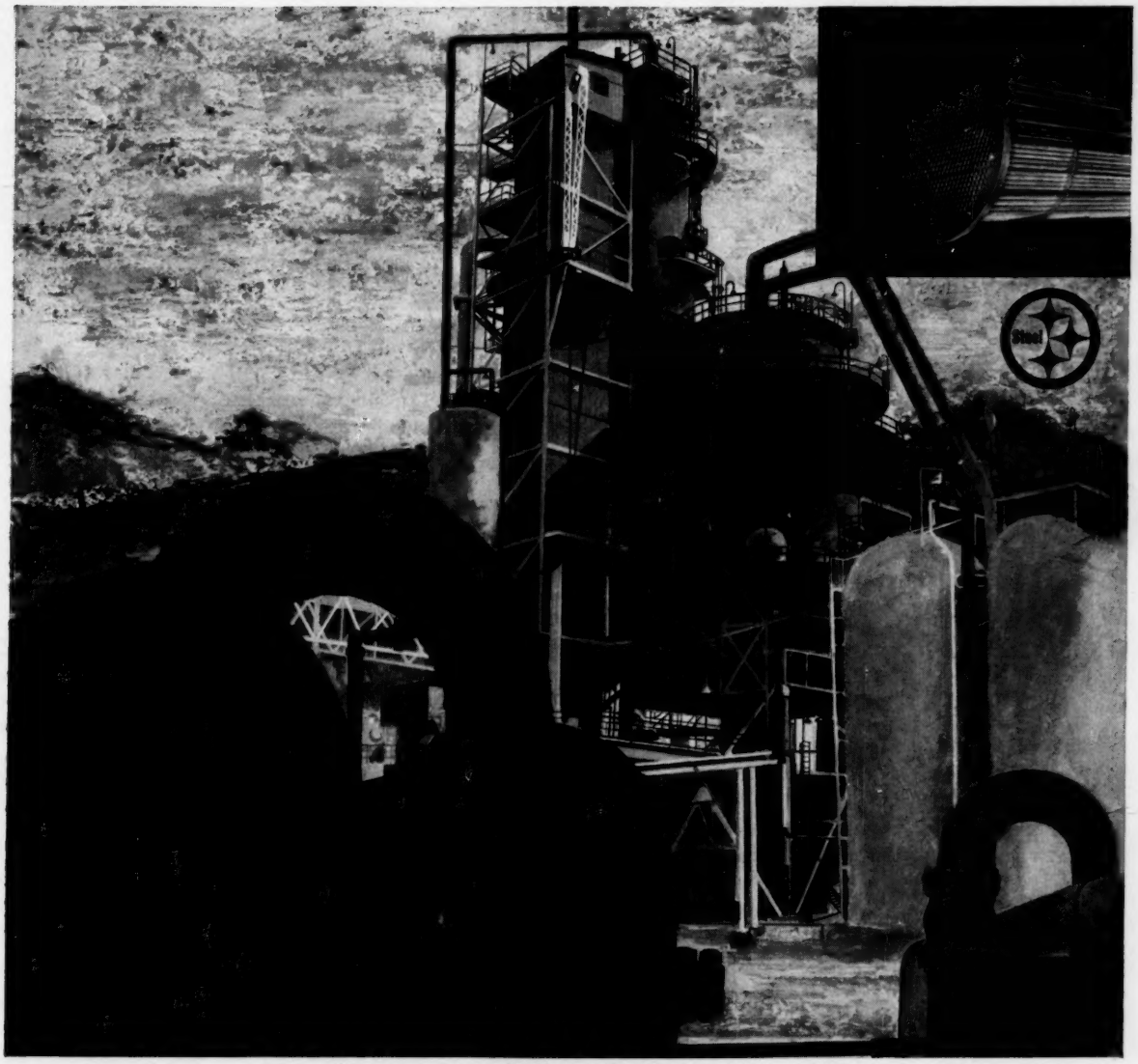

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Today, mining companies can sell just about all the beryl they can produce for around $400/ton. With the coming upswing in demand, Standard wants a more efficient beryl-producing method than the conventional hand-sorting technique.

Standard Beryllium has one of the largest known beryllium deposits: probable reserves total 350,000 tons of beryl on a 1,700-acre site, 200 miles north of Rio de Janeiro. The pegmatite ore contains 3% beryl (about 0.3% BeO). The flotation process can concentrate this to well over 11% BeO with recoveries over 90%.

The firm is also looking at an electrostatic process for concentrating beryl from the host rock. Advantages would be lower power and reagent needs; cost would be only 25% of flotation. Work on this process is still in the research stage, however.

Variations on solid fuels seen as way to get big boost at low cost

As U. S. missilemen search for the "breakthrough" that President Kennedy has stated we need to overcome Soviet superiority in big-booster thrust, variations on the standard solid-fuel propellant are being given much attention.

Atlantic Research Corp., which developed the high-energy solid propellants for the Polaris missile, is proposing a new type of gel-solid that would have the advantage of solid fuels but cost less to produce. This new slurry fuel would have the consistency of toothpaste and would never harden.

The fuel could be kept in trays stacked inside the rocket body. As the trays of fuel burned, the hot exhaust gases would flow downward through a central channel and out the nozzle.

Gel fuels, says Atlantic, will have all the simplicity, versatility and reliability of conventional solid fuels. In addition, the gel would be easier to make than the complex mixing, casting, curing and machining methods now required for solids. Inexpensive gel fuel could be shipped by tank car to the launch site where it would be pumped into a rocket that could be assembled on the spot.

In another development, several firms are promoting segmented solid-fuel motors (several sections fastened together). For big boosters, it's easier to make several smaller sections than to cast and machine one large slug. These firms believe that our present solid-fuel technology could be scaled up to make segmented solid-fuel boosters with up to 3-million-lb. thrust, and that this is the U. S.'s best chance for rapid development of big economical rockets.

United Technology Corp., for example, is now in final negotiations with the National Aeronautics and Space Administration for construction of a 250,000-lb.-thrust segmented solid-propellant motor. The conical engine, which will be 40-ft.-high and 10-ft.-dia. at its widest point, is slated for static firing this summer. The company is also planning to test-fire a 500,000-lb. segmented motor before year's end.

Attractions of oxo production may create big capacity bulge

The apparent simplicity of oxo alcohol manufacture has lured a clutch of new producers into the field. Recent additions will raise U. S. capacity from today's 400 million lb./yr. to over 610 million lb. in 1962.

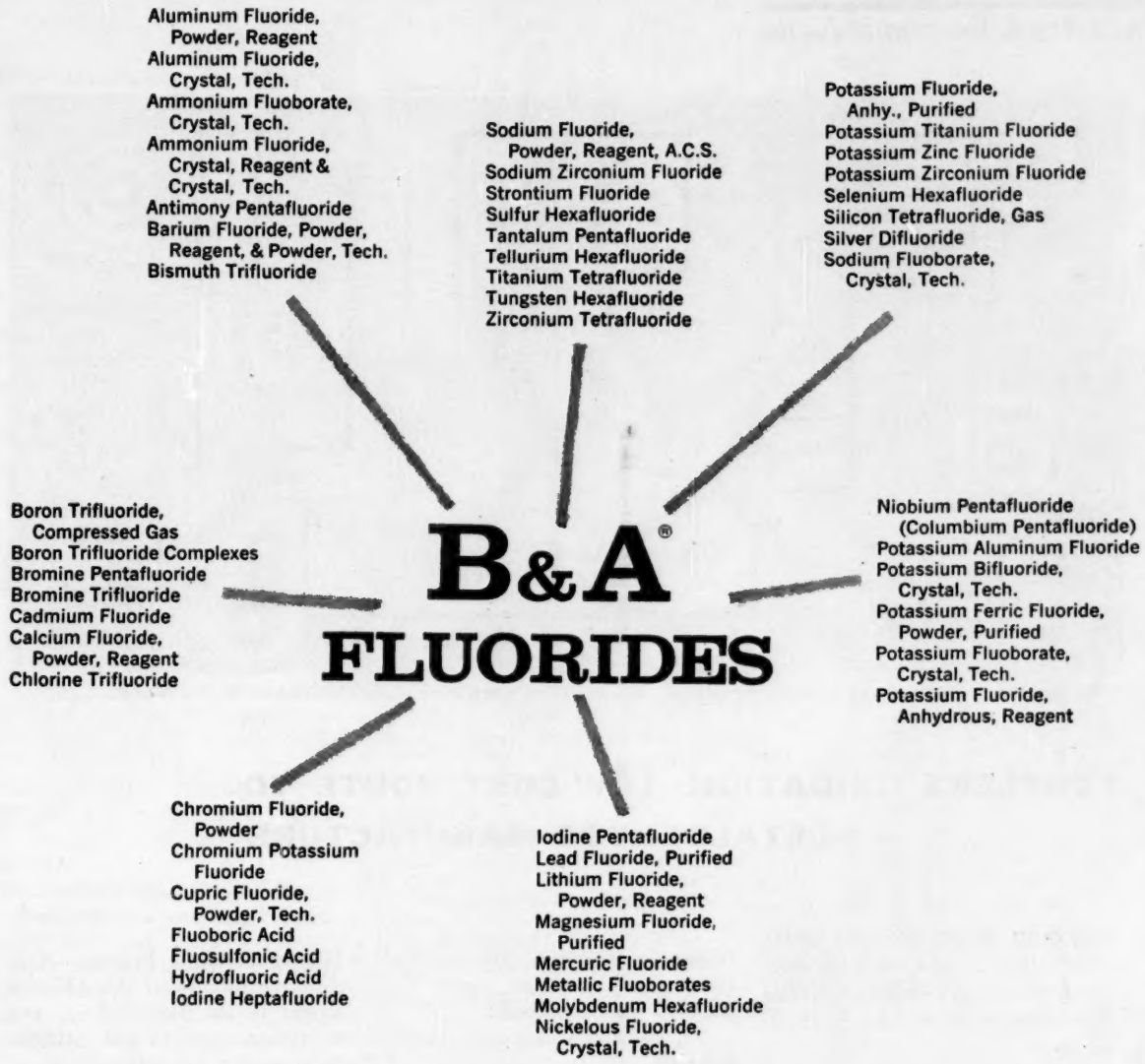
Latest oxo venture will team Tidewater Oil with Air Products to erect a 60-million-lb./yr. plant adjacent to Tidewater's Delaware City, Del., refinery. Tidewater will operate the plant; Air Products will do the engineering and have sales responsibility for the products.

Among the attractions of oxo production is that the technology is relatively straightforward: it uses ordinary refinery streams (propylene or heptene), investment is moderate and the bulk of sales are to a few large consumers.

These were part of Air Products' motivations for its first venture into petrochemicals. The joint project is a new tack for the firm, which has wanted to get into chemicals for a long time, declares a company spokesman. He calls the move the first of a series of projects to change Air Products from a capital goods to an operating company.

But motives for other new oxo capacity are not so clear-cut. Present estimated 125-million-lb./yr. consumption is mostly in plasticizers where demand is expected to grow to only about 200 million lb. by 1965. Most producers, however, control their raw materials, or have a captive market, or both. Bulk of the Tidewater-Air Products output, for example, has already been contracted by Reichhold Chemicals.

For More Industry & Economic News . . . p. 66



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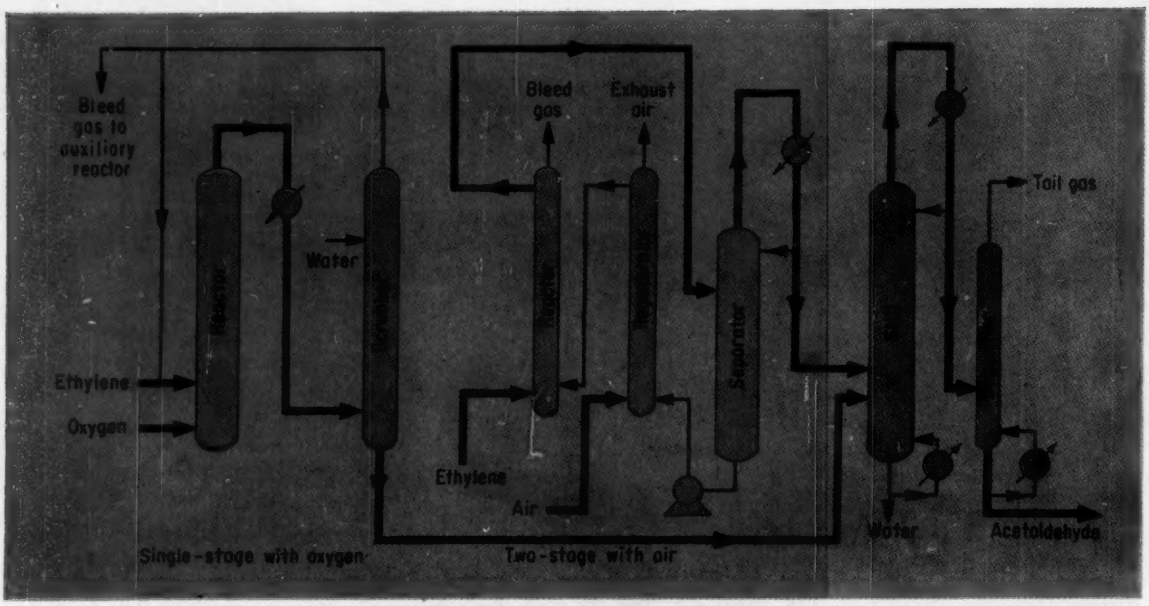


CH_3CHO can be made by two different processes. But each employs a similar distillation and degassing section (right).

ETHYLENE OXIDATION: LOW-COST ROUTE TO ACETALDEHYDE MANUFACTURE

German process uses less-expensive raw material and equipment, gets higher yields than conventional U.S. techniques.

Celanese Corp.'s recent disclosure (*Chem. Eng.*, Feb. 20, p. 73) that it has licensed the Aldehyd GmbH acetaldehyde process for its new Bay City, Tex., plant injects new interest into the domestic acetaldehyde picture.

With this process, Celanese becomes the first U.S. producer to manufacture acetaldehyde by direct oxidation of ethylene.* Other producers use the less-direct route from ethylene through ethyl alcohol to acetaldehyde, or start with more-expensive acetylene.

To substantiate the obvious advantage of producing a chemical from a less-expensive starting material via a shorter route, the Aldehyd GmbH process:

- Produces yields approximating 95%.
- Operates at low temperatures and pressures.
- Produces negligible amounts of byproducts.
- Requires minimum capital investment and utilities.

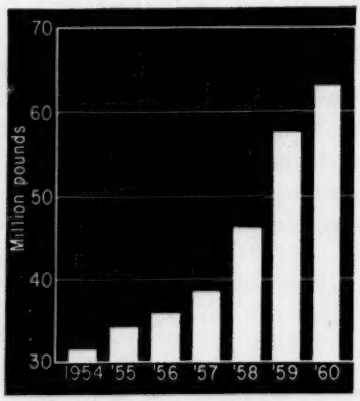
Out of these advantages now gained by Celanese may come competitive pressure that will stimulate price activity in the acetaldehyde market.

For the most part, acetaldehyde goes into captive conversion to alcohols, aldehydes, plastics, lacquers and insecticides. And any competitive action will have its major impact on the prices quoted for these materials. However, sales of acetaldehyde for non-captive use have doubled since 1954, increasing the relative importance of price action in this market area.

► **Highly Versatile Process**—Most attractive feature of the Aldehyd process is its flexibility—it can use either pure oxygen (single-stage) or air (two-stage).

A decision as to which route is

Acetaldehyde: domestic sales



Source: U. S. Tariff Commission

* In Germany, Farbwerke Hoechst operates a 24,000-ton/day plant at Frankfurt; Wacker Chemie a similar sized plant at Cologne. In Italy, Societa Edison has a 24,000-ton plant near Mantova, and in Mexico, Pemex began construction of a plant last year at Salamanca.

more advantageous depends on local conditions such as oxygen cost, ethylene purity and utility prices.

Chemistry involved in the process can be summarized as follows:

$$C_2H_4 + \tfrac{1}{2}O_2 \xrightarrow{\text{catalyst}} CH_3CHO$$
$$\Delta H = -52K \text{ cal.}$$

The catalyst, an aqueous solution of copper chloride with small quantities of palladium chloride, acts as the oxygen carrier and causes selective conversion of the olefin to a carbonyl compound. In the reaction, there are several steps that boil down to:

(1) $C_2H_4 + 2CuCl_2 + H_2O \xrightarrow{PdCl} CH_3CHO + 2HCl + 2CuCl$ (reaction)

(2) $2CuCl + 2HCl + \tfrac{1}{2}O_2 \longrightarrow 2CuCl_2 + H_2O$ (regeneration)

During the reaction, palladium chloride reduces to palladium and HCl. The $CuCl_2$ acts as the oxidizing agent for Pd. On catalyst regeneration, the CuCl is reoxidized. This completes the cycle and results in a continuous process. The reaction and regeneration steps can be conducted separately or together.

► **Single-Stage Oxidation**—Fed to a vertical reactor, ethylene, oxygen and recycle gas react with the catalytic solution by boiling under slight pressure. Water that evaporates during this reaction and some makeup water (to maintain concentration of the catalytic solution) dissipate the heat of reaction.

Gas effluent is scrubbed with water and the resulting aqueous acetaldehyde solution goes to a distillation column.

Composition of the scrubbed gas (mostly oxygen and unreacted ethylene) is controlled automatically. This gas is recycled to the reactor by a blower, and a side stream is further converted in an auxiliary reactor.

► **Two-Stage Oxidation**—This process differs from the single-stage because spent catalyst is regenerated in a separate reactor.

Most of the ethylene is converted by single-pass contact with the catalytic solution in a reactor operated at a moderate temperature but at a pressure higher than that used in a single-stage setup.

After pressure is decreased, heat of reaction in the separator vaporizes the acetaldehyde, which is distilled to give a concentrated crude product. Spent catalyst solution is pumped to the second reactor, regenerated and recycled.

This two-stage process can also be operated with oxygen. And it can handle an ethylene-rich gas instead of pure ethylene.

The accompanying tables present economic evaluations of the

Estimated investment including engineering—Table I

Capacity, (Tons/Yr.)	Battery-Limit Plant	
	Single-Stage	Two-Stage
16,530	$1,375,000	$1,675,000
33,060	$2,025,000	$2,400,000
66,120	$2,925,000	$3,700,000

Raw-material, utilities, personnel requirements—Table II

Raw material	Per Ton of Acetaldehyde	
	Single-Stage	Two-Stage
Ethylene (100-190 psi., 99.7% pure)	1,342 lb.	1,342 lb.
Oxygen (100 psi., 99% pure)	9,288 scf.	.....
Hydrochloric acid and catalyst	$1.36	$2.72
Utilities		
Cooling water	9,605 cu. ft.	6,403 cu. ft.
Well water	.....	48 cu. ft.
Deionized water	96.1 cu. ft.	6.44 cu. ft.
Steam (200 psi.)	1.3 ton	0.3 ton
Steam (66 psi.)	0.3 ton	0.9 ton
Electric power	190 kwh.	336 kwh.
Personnel (1 supervisor, 1 foreman) Man-Hours:		
For 16,530 ton/yr	1.741	1.741
For 33,060 ton/yr	0.870	0.870
For 66,120 ton/yr	0.435	0.435

Total hourly requirements (8,000 operating hours annually)—Table III

Single-stage with oxygen	Capacity in Tons per Year		
	16,530	33,060	66,120
Ethylene (100 psi., 99.7% pure)	35,500 scf.	71,000 scf.	142,000 scf.
Oxygen (100 psi., 99% pure)	19,200 scf.	38,400 scf.	76,800 scf.
Cooling water	20,300 cu. ft.	40,600 cu. ft.	81,200 cu. ft.
Deionized water	212 cu. ft.	424 cu. ft.	812 cu. ft.
Steam (200 psi.)	2.75 ton	5.4 ton	10.8 ton
Steam (66 psi.)	0.66 ton	1.2 ton	2.5 ton
Electric power	400 kwh.	800 kwh.	1,600 kwh.
Two-stage with air			
Ethylene (100 psi., 99.7% pure)	35,500 scf.	71,000 scf.	142,000 scf.
Cooling water	13,240 cu. ft.	26,480 cu. ft.	52,960 cu. ft.
Well water	990 cu. ft.	1,940 cu. ft.	3,880 cu. ft.
Steam (200 psi.)	0.66 ton	1.2 ton	2.5 ton
Steam (66 psi.)	1.87 ton	3.75 ton	7.5 ton
Electric power	700 kwh.	1,400 kwh.	2,800 kwh.

process. Costs are based on the assumption that ethylene is available at 100-190 psi. (at minimum purity of 99%) and that, in the single-stage process, oxygen comes from an existing oxygen plant, so that new facilities are not needed for ethylene and oxygen requirements.

Investment costs (Table I) are based on the actual capital requirements of plants already in operation and—unfortunately—on German wage and material price levels.

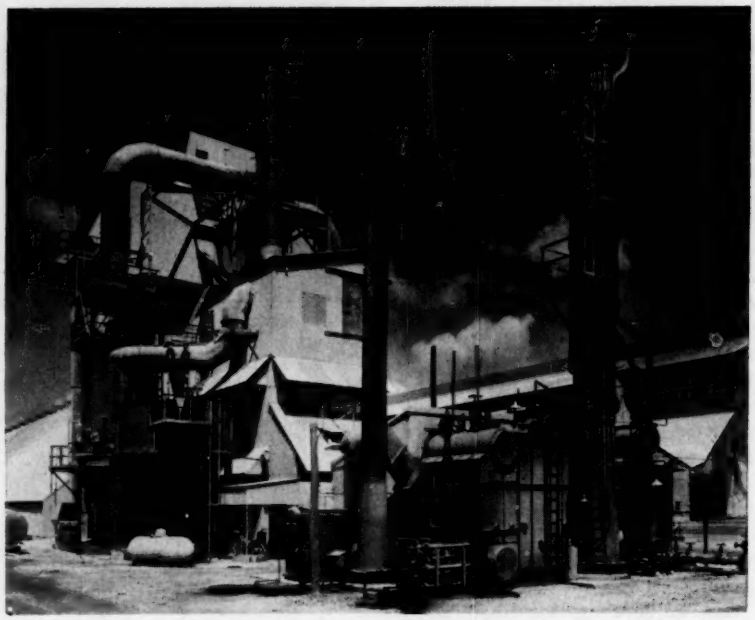
These costs include all required equipment as well as structural steel, buildings, complete instrumentation and control, electric power distribution, intermediate tankage, engineering and erection of the complete battery-limit facilities and initial inventory of catalytic solution.

But they do not include auxiliaries such as product storage, steam generation facilities, power transformer unit, water treating or site acquisition and preparation.

Raw-material and utility requirements are given in Tables II and III.—EG

AMMONIATED PHOSPHATES HIGHLIGHT FERTILIZER SHIFT

Techniques for making concentrated ammoniated products headline the changes taking place in phosphate plant foods.



Simple, direct DAP route is used in Tennessee Corp. unit, Tampa, Fla.

There's nothing static about the phosphate fertilizer business these days. A pronounced shift toward greater consumption of high-analysis plant foods is taking place hand in hand with a rash of technological developments, as new fertilizer processes and plants appear almost daily.

A look at the fate of ordinary superphosphate, long the basic standby for introducing phosphorus to the soil, underlines this shift. As recently as 1954, superphosphate grades containing 40% or less of available phosphoric acid made up over 74% of the total phosphatic material used for fertilizer in the U.S. By 1960, this figure had dropped to less than 48%.

Although concentrated superphosphates have been taking up most of the slack, products developed more recently are—or show high promise of—beginning to make their presence felt. Among the most exciting are mixed goods that combine ammonium and phosphate radicals in highly concentrated packages.

Three current developments headline this area: TVA's pilot work on ammonium polyphosphate, Tennessee Corp.'s 100% expansion of its diammonium phosphate capacity at Tampa, Fla., and Illinois Farm Supply Co.'s continued refinement of the Seymour ammoniation process at its East St. Louis, Ill., fertilizer plant.

▶**Promising Polyphosphate**—TVA describes its ammonium polyphosphate, containing about 16% nitrogen and 61% phosphorus pentoxide, as more concentrated than any fertilizer now on the market.

Product is a granular, completely water-soluble combination of monoammonium phosphate and a gel of polyphosphates, which is now being made on a pilot scale at Muscle Shoals, Ala. Preliminary estimates indicate that production costs per unit of plant nutrient will be roughly comparable to those of diammonium phosphate.

TVA foresees diversified fertilizer uses for polyphosphate, including direct application to the soil and blending with other materials. The product's potential for liquid-fertilizer applications looks especially attractive. Dissolving ammonium polyphosphate in water can produce a liquid containing as much as 44% plant food (10% nitrogen, 34% phosphorus pentoxide). And, the material prevents precipitation of impurities from ammoniated wet-

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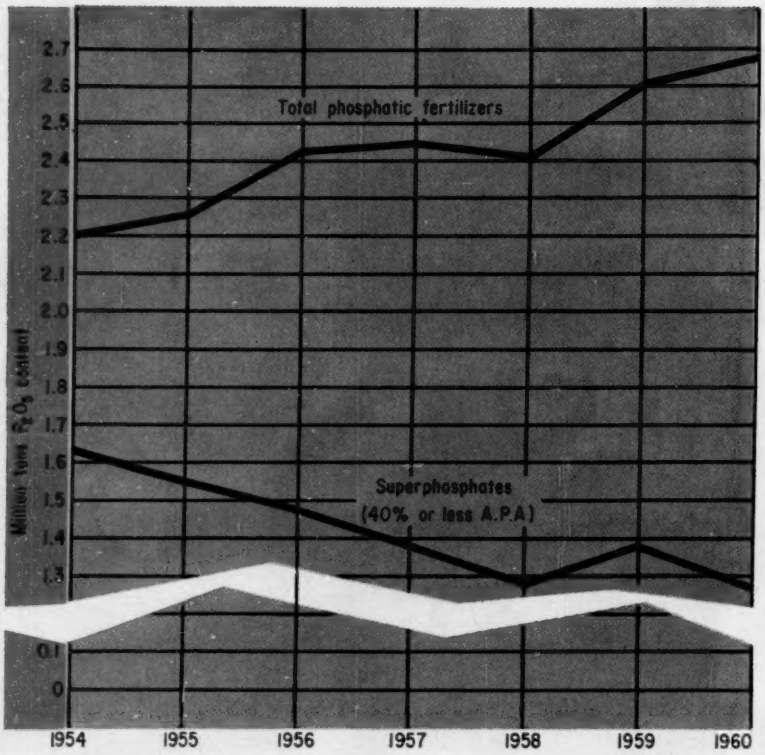

Diverging fertilizer pattern: total phosphates up, superphosphates down.

process phosphoric acid, thus providing a good means for producing liquid fertilizer from wet-process acid.

► **How It's Made** — Ammonium polyphosphate is an outgrowth of another TVA development: superphosphoric acid, which is a concentrated phosphoric acid that contains 76% phosphorus pentoxide and is liquid at ordinary temperatures (*Chem. Eng.*, Dec. 29, 1958, p. 32).

Pilot process at Muscle Shoals makes ammonium polyphosphate by feeding ammonia and superphosphoric acid to a reactor that operates under moderate pressure (10-300 psig.) and around 375 F. At these conditions, the reaction product is a free-flowing melt. In original bench-scale work, TVA carried out granulation by mixing the melt with recycled fines in a pug mill; in the pilot plant, the polyphosphate granules form as the melt spreads over recycled fines in a rotating drum.

The agency's superphosphoric acid is a furnace acid; accordingly, most of the work on ammonium polyphosphate has been with use of this furnace product as feedstock. But, TVA is also studying techniques to concentrate wet-process acid to a phosphorus-pentoxide level —about 70%—comparable to that of superphosphoric, and has produced some ammonium polyphosphate using the wet-process product as feed. So far, it appears that furnace superphosphoric leads to a slightly better polyphosphate.

Likely next step, says TVA, will be a small demonstration plant at Muscle Shoals, designed from data supplied by the pilot unit. TVA engineers point out that making ammonium polyphosphate is more of a chemical process than are many mixed-fertilizer operations; hence, it may require some "selling" to fertilizer manufacturers. Specifics for the demonstration plant haven't been finalized yet, but TVA expects to start its design within a few months.

► **Diammonium Phosphate** — A comparative newcomer to the commercial fertilizer picture, DAP has been making news, too: Tennessee Corp.'s U.S. Phosphoric Products Div. is finishing up an expansion program that doubles the capacity of its DAP unit at Tampa, Fla., to 200,000 tons/yr.

The Tampa facility has been on stream since April 1959. Product—granular diammonium phosphate, trade-named Di-Mon—ranks high as a concentrated fertilizer, analyzing about 18% nitrogen and 46% phosphorus pentoxide.

Company says its process is "unique in that the reaction and granulation are accomplished in an unusually simple flow." Although details on the Tampa unit are not available, much information on the firm's diammonium phosphate technology can be gleaned from a study of the U.S. patent, 2,963,359, assigned to Tennessee Corp.

► **Key Features** — Heart of the process is a moving bed of recycle product fines; liquid wet-process phosphoric acid sprays over the top of the bed, and liquid or gaseous anhydrous ammonia enters from the bottom. DAP-producing reaction takes place within the bed; the product builds up as layers on the individual fines.

The bed is housed preferably in a rotating drum, although other equipment can be used instead. The drum alone can act as reaction vessel, mixer, granulator and partial or complete dryer.

Recycle material constituting the bed should be mainly minus-10 to plus-60 mesh, according to the patent. Recycle rate should be roughly three times product-withdrawal rate, depending on the acid concentration used. Bed depth is 7-12 in. if a drum is used, or about 24-36 in. for other equipment.

Heat of neutralization between the acid and ammonia drives off water as steam. A flow of air can be passed through the top of the drum to prevent condensation, and when hot air is used the drum provides all the drying required.

It is important to control the amount of moisture in the system. With the recycle/product ratio of

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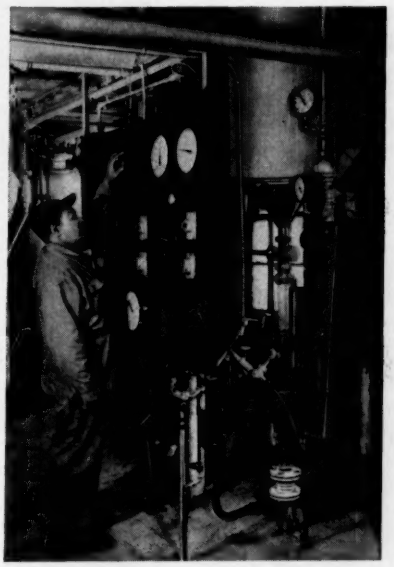
Louis T. Rosenberg, Production Manager of Nopco's Organic Chemicals Division, has said, "The only real maintenance the Turba-Film Processor has required has been preventive. At our annual vacation shut-down, we open up the equipment for a general check-up and overhaul. We always inspect the carbon bearings, but have found that these need replacement only after 2 or 3 years. And on reassembly we install new O-rings and seals."

Further evidence of the processor's reliability is the fact that for the past 2½ years, it has been operating virtually around the clock – 24 hours a day, 7 days a week. Operation is continuous, except for a brief shut-down between shifts, or when changing over to another process.



Nopco uses the Turba-Film Processor for handling various heat-sensitive compounds. Less than 10 seconds' exposure at operating temperature and pressure is required for any single particle of the material so that impairment of the product is kept at a minimum. Operating conditions may vary from atmospheric to 35 psig jacket steam pressures and from atmospheric to 20 mm internal pressures.

Accurate and effective control of variables is important in the manufacture of Nopco's products. An elaborate system of interlocked controls enables the Turba-Film Processor to produce concentrations with variations limited to less than 1%. The load on the rotor is determined by an ammeter. If the load should suddenly increase above the motor's rating, the power would be automatically shut off. If, on the other hand, the load should not increase instantly, the operator can adjust conditions so that power load will return to normal. This can easily be accomplished by either a reduction in feed rate or jacket steam pressure.

According to Mr. Rosenberg, "Any change in feed rate or steam pressure is reflected in our product composition within 10 seconds. Because of its design and stainless steel construction the Turba-Film Processor is strikingly easy to clean. That's important to us. We can switch from turning out one product to another in minutes."

Long-term dependability and efficiency such as this continues to be a built-in feature of the patented Turba-Film Processor. Since Rodney Hunt introduced the first satisfactory thin-film processing technique in this country, more Turba-Film Processors have been installed than the combined total of all other types of mechanically controlled thin-film processing equipment. Through this leadership, Rodney Hunt has developed unequalled knowledge and experience in the application and manufacture of thin-film equipment to solve even the most difficult processing problems.

FOR MORE INFORMATION ABOUT THE TURBA-FILM® PROCESSOR

For the complete story about the Rodney Hunt Turba-Film Processor, write to the address shown above for Bulletin 117.

In addition to the design features and operational details of the processor, this 24-page bulletin includes a number of typical flow sheets illustrating the equipment's versatility in such processes as deaeration, distillation, deodorization, concentration, desolventization, homogenization, and others. A handy form is included for your use to enable us to supply technical data matched to your particular needs.

TURBA-FILM® PROCESSOR FINDS EVER WIDER APPLICATIONS

The versatile Rodney Hunt Turba-Film Processor continues to add to the wide variety of its application in every type of processing industry. Its unique use of the controlled thin-film processing technique is making many new products possible and is proving to be the answer to many complex processing problems.

Among the dozens of Turba-Film Processors shipped during 1960, many were for the more usual areas of application such as organic chemicals, petroleum sulfonates, latex, resin, urea, etc. But others were for new or unusual applications. One major producer, for example, who has long used Turba-Film Processors for latex, is now using another unit in the production of PVC, a polyvinyl plastic. Several companies are using the units in the production of glue. A well-known food company is using a Turba-Film Processor in the manufacture of candy, and another is processing tea and coffee.

A major use of the Turba-Film Processor in the food industries, as well as in the production of pharmaceuticals, has been in the processing of lecithin. The *first continuous processing* of lecithin, in fact, was made possible through the pioneering efforts of Rodney Hunt engineers.

Prior to that time – although other equipment in the lecithin production process was adaptable to continuous operation – the complete water removal step could be accomplished only by a difficult batch or semi-continuous process. Through cooperative research with various companies interested in the process, Rodney Hunt engineers proved that the Turba-Film Processor could make the production of lecithin a completely continuous process with only one pass through the equipment. Today there are many Turba-Film Processors processing lecithin and producing an improved product.

Among other food industry applications for the Turba-Film Processor have been in the concentration of apricot and tomato purees, deodorization of edible oils, the processing of honey and sugar, the concentration of corn syrup and gelatin and the processing of sugar esters. Still other applications are in research and testing stages at Rodney Hunt's laboratories in Orange, Massachusetts, many of these in cooperation with other companies.

NEW SALES AGENCY APPOINTED FOR PROCESS EQUIPMENT DIVISION

The J. A. Brown Co. of Philadelphia has been appointed to serve as Sales Representatives for the Turba-Film Processor and other Rodney Hunt process equipment in lower New Jersey, eastern Pennsylvania, Delaware and eastern Maryland.

The J. A. Brown Co. is located at 1616 Walnut Street, the telephone is KI 5-7883.

Ask us for the name of our representative in your area.

3, the patent recommends that acid concentration be 40-43% phosphorus pentoxide. Sufficient moisture must be present to maintain the reaction and help form granules, but too much can cause caking and agglomeration.

Excess ammonia is used during the reaction. Unreacted portion leaves the vessel and is absorbed by phosphoric acid in a venturi scrubber; partially neutralized acid then goes to the reaction bed where DAP is formed.

In addition to U. S. Phosphoric's operation, TVA is piloting a new DAP process that includes many of the same features. A basic difference is that TVA introduces part of the fresh ammonia to a pre-neutralizer rather than the reaction vessel, in addition to absorbing off-ammonia in a scrubber. Water is removed by heat of reaction in the preneutralizer. The Authority cites efficient use of chemical heat, ease of control and low recycle as features of its process.

▶**Seymour Process**—The Seymour mixed-fertilizer process features self-granulation and high ammoniation efficiency. Originally developed by Central Farmers Fertilizer Co., Chicago, it has been in use for over two years at an East St. Louis, Ill., plant of Illinois Farm Supply Co. (one of the co-operatives that own CFF).

Route differs from general solid-fertilizers manufacture in that the feed is normally a material already high in phosphate content. It was originally developed for treating calcium metaphosphate, but IFS has since modified the operation so that triple superphosphate can be used as well.

Basically, process consists of combining exothermally reactive fertilizer components as a slurry, then drying and granulating the reaction mixture. A potassium salt may also be added during granulation, to yield a complete mixed product.

Typical operations possible are direct ammoniation of superphosphate (ordinary or triple), and ammoniation of slurries formed either by combining superphosphate and a mineral acid or by hydrolyzing calcium metaphosphate.

▶**A Look Inside**—Key to the Seymour process is the equipment in which it takes place. The unit at East St. Louis consists of a compound, double pug mill made up of three sections in series. Each downstream section is at right angles to the one before it, and the junctions between these zones is such that the flowing, in-process material provides a vapor seal for each of the two upstream ones. This conserves heat and moisture, helps prevent ammonia loss from the reaction zones.

Solid, phosphatic feed enters the first section with water, and also with acid if required. Mixture advances downstream and enters the second section, where ammonia is introduced. Resulting exothermic reactions produce a hot, substantially liquid mixture saturated with ammonia salts, which in turn enters the final zone. Potassium salt is also added here if desired. An air current provides evaporation and cooling in this zone, and the mixture crystallizes into finished granules.

▶**In Operation** — Illinois Farm Supply has treated both calcium metaphosphate and triple superphosphate, has included sulfuric and phosphoric acids in its formulations. Principal product analyzes 7% nitrogen, 28% phosphorus pentoxide and 14% potash.

The firm found corrosion to be a big stumbling block during early operation, then surmounted this by using pug mills made of an alloy that consists mainly of nickel, chromium and molybdenum. Although this material costs about three times as much as ordinary stainless steel, CFF declares that the East St. Louis operation is competitive with other plants producing N-P fertilizers. And, a modification currently under way promises to make the process competitive on a new-investment basis as well.

CFF points out that in addition to the effective energy-conservation and ammoniation mechanism of the system, the product granules are 55% water soluble, fully homogeneous (without layering effect) and have a clean, white appearance that enhances farmer appeal.—NPC

First HDA Benzene Plant To Be Built in Argentina

First installation of Hydrocarbon Research's HDA thermal hydrodealkylation process (*Chem. Eng.*, Apr. 17, p. 128) will be made in a new grass-roots refinery to be erected at San Lorenzo, Argentina, about 200 miles northwest of Buenos Aires.

The $15-million refinery, to be built by HRI for Yacimientos Petroliferos Fiscales, will turn out 8,000-11,000 bbl./day high-octane gasoline and 700 bbl./day benzene. Benzene capacity could be expanded to 1,200 bbl./day, if demand for benzene comes up to expectations.

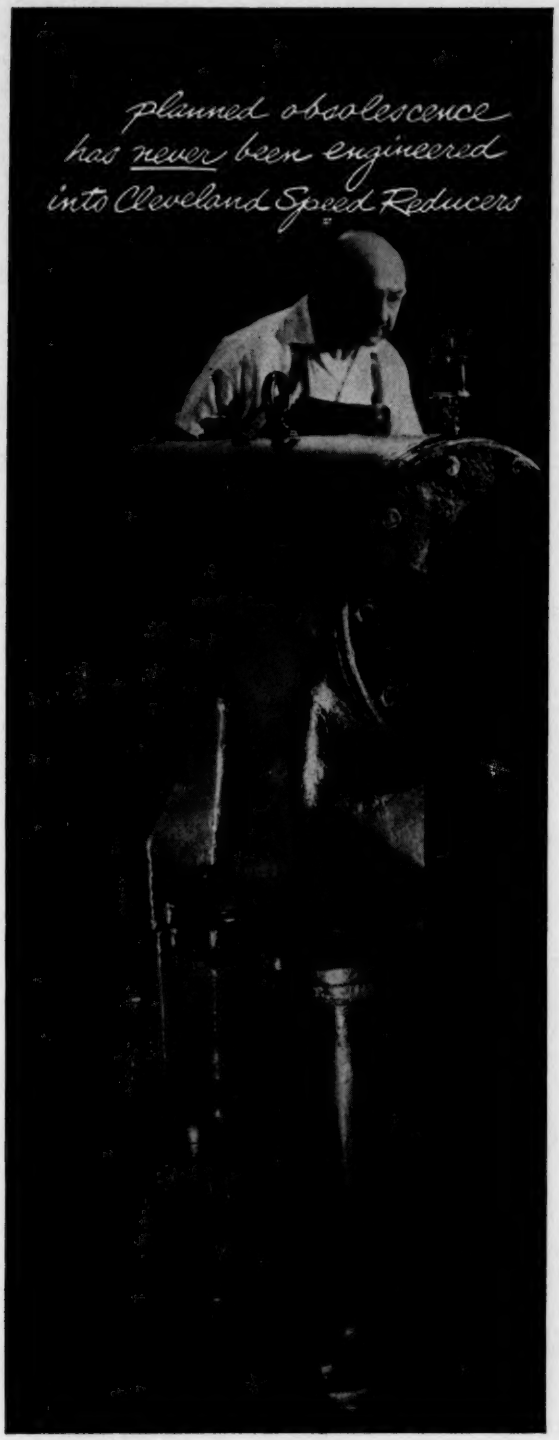
Refinery will include a catalytic reformer and aromatics extraction unit, which will supply the raw material to the HDA plant. Feedstock to the reformer will be about 12,000 bbl./day of naphthas. This is to be supplied from Yacimientos' refineries in San Lorenzo and Campo Duran.

New Tools Being Forged In Search for More Potash

Latest development in the potash boom is a joint venture between Pittsburgh Plate Glass and Armour & Co. to tap Saskatchewan's vast potash deposits by solution mining. This technique, never before tried on potash, consists of forcing water down into a mineral deposit where the desired material is dissolved. Solution is then forced back up the recovery well by hydrostatic pressure.

The $1-million pilot drilling program is designed to avoid ground water problems that beset International Minerals & Chemical and Potash Co. of America when they tried to mine these deposits by conventional methods. PPG will supervise drilling, drawing upon its experience in solution mining of sodium chloride at depths as great as 6,800 ft.

Another potash producer, American Metal Climax, also has hundreds of millions of tons of potash reserves in the Saskatchewan area.



In service 40 years... never overhauled!

After *40 years of continuous service* at Alcoa's New Kensington, Pennsylvania plant, this rugged Cleveland Worm Gear Speed Reducer was slated for an overhaul.

As this unit—which continuously drives a foil mill—had never been opened before, a thorough, painstaking inspection was made by Cleveland service engineers. They found the reducer required *only* a new worm radial bearing to put it in top notch operating shape. Even the gear's working face was in almost factory-new condition—after 40 years of rugged, heavy-duty operation!

As our engineers left the plant, Alcoa personnel remarked, "Well, we'll see you again in another 40 years."

We are extremely proud of this experience at New Kensington. It serves to point up our belief that building product quality and performance in Cleveland Reducers is still the main reason we are in this business. We know from experience that industry welcomes quality products—and we will *continue* to produce them.

* Today, some capital goods producers seem to be guided by the philosophy that in this age of rapid change in manufacturing methods and equipment, the resulting high rate of obsolescence does not justify the costs entailed in building long operating life into a product. This is not true of Cleveland—and never will be.

Why not talk to your Cleveland Representative and get the latest information on Increased HP Worm Gear Speed Reducers. Or write for your free copy of our latest illustrated literature—it contains the story of today's finest reducers.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3275 East 80th Street • Cleveland 4, Ohio

CLEVELAND
Speed Reducers

CHEMICAL SPENDING ADVANCES CAUTIOUSLY

In the wake of some of the lowest operating rates in recent years, several CPI segments have cut back since last fall. Exceptions: chemicals and petroleum.

ALFRED LITWAK
McGraw-Hill Dept. of Economics

Total CPI capital expenditures in 1961 will be a shade higher than in 1960, according to the 14th Annual McGraw-Hill Survey of Business Plans for New Plants and Equipment.

Chemical industry producers and petroleum refiners expect to spend more for new plants and equipment in 1961 than was allocated in 1960. However, pulp and paper makers, rubber manufacturers, and stone, clay and glass products producers plan to trim capital expenditures this year.

In the chemical industry, capital outlays now planned for 1961 total nearly $1.7 billion, an increase of 4% from 1960's spending level. Moreover, chemical manufacturers have added to their scheduled capital expenditures in recent months. As a result, projected outlays for 1961 exceed the level reported for chemical producers in the McGraw-Hill survey conducted last fall (*Chem. Eng.*, Jan. 9, 1961, p.48).

Petroleum refiners plan to raise spending 30% from last year, bringing outlays for new plants and equipment to $803 million in 1961. This increase exceeds by a wide margin the increases anticipated by other manufacturing industries.

Pulp and paper producers, on the other hand, plan to cut back capital expenditures in 1961. They now envision a 9% reduction, shrinking outlays for the year to $680 million. Rubber producers, similarly planning reductions, have slated this year's capital expenditures at $220 million, a 6% drop. In both these industries, cutbacks in capital spending now planned exceed those anticipated at the time of McGraw-Hill's survey last fall.

Process industries' plans reveal divergent trends

Capital Spending (Million Dollars)

	Present Status		*Future Plans*		
	Planned 1961	% Change 1960–1961	1962	1963	1964
Chemicals	1,660	+ 4	1,580	1,600	1,740
Paper & Pulp	680	− 9	600	610	620
Rubber	220	− 6	230	240	240
Stone, clay & glass	590	− 5	550	550	530
Petroleum refining	803	+30	835	760	798
Nonferrous metals	310	0	350	410	460
All manufacturing	14,090	− 3	13,920	13,600	13,710

	Capacity Operating Rate		Capital Spending Planned for 1961	
	Preferred	Actual	Expansion	Replacement & Modernization
Chemicals	93%	75%	65%	35%
Paper & pulp	100	88	32	68
Rubber	96	76	44	56
Stone, clay & glass	90	70	49	51
Petroleum & coal products	97	81	11	89
Nonferrous metals	96	72	40	60
All manufacturing	94	77	33	67

	Capacity Increase *Index of Indust. Capacity* (*Dec.* 1950 = 100)		
	1959–60	1960–61	1961–64
Chemicals	6%	6%	14%
Paper & pulp	5	6	7
Rubber	4	5	11
Stone, clay & glass	3	4	11
Petroleum & coal products	2	0	6
Nonferrous metals	7	2	10
All manufacturing	4	4	10

Stone, clay and glass producers, in contrast, have expanded their earlier spending plans to $590 million for new plants and equipment this year. Although this represents a 5% decline from last year, the drop is substantially less than was anticipated late last year.

▶ **Operating Rates, Low**—Current spending plans follow in the wake of some of the lowest operating levels in recent history. As 1960 ended, plants and equipment in every manufacturing industry indicated were operating well below desired output levels (see above).

Undoubtedly, this situation induced some caution in planning 1961's capital outlays. But it also suggests that current spending plans will be revised upward as business activity begins to improve.

▶ **Major Goal, Modernization**—A key reason for continued heavy investment in new plants and equipment by U. S. manufacturers is the need to modernize obsolete capital equipment and to introduce cost-cutting processes wherever possible.

Only the chemical industry has budgeted more for additions to capacity than for modernization in 1961.

Stone, clay and glass producers will give a razor-thin edge to modernization, apportioning 51% of outlays to that goal while earmarking 49% for expansion. Other producers in the CPI group plan substantially greater outlays for modernization, with petroleum and coal products producers slating as much as 89% for this purpose.

Looking beyond 1961, manufac-

YORK Multi-Stage Turbomaster Ideal For Applications Down To 800 cfm

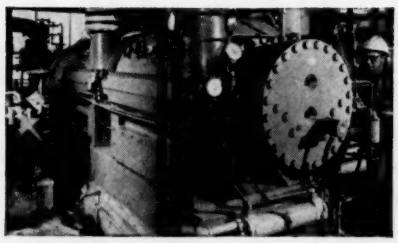
—Offers greater efficiency even for small loads

COMPACT AND ECONOMICAL—On small jobs, Turbomasters offer smoother, pulsation-free operation with virtually no maintenance. On big jobs, two small units can be used, rather than one large machine, to "spare" the system economically.

PRE-ROTATION VANE CAPACITY CONTROL—Standard on all Turbomasters, these vanes provide automatic, continuously variable capacity. This means that compressor capacity stays in direct proportion to load for high system efficiency.

OPERATE BELOW CRITICAL SPEED—Turbomasters up to 6 stages operate well below critical speed. Short, stiff shaft and lightweight aluminum rotors make this possible. Impeller assembly factory-tested at an over speed of 20% or more to insure reliability.

VERSATILE TO MEET YOUR REQUIREMENTS—Up to 8 stages in one casing with choice of casing and rotor materials and sizes, plus side loading and interstage connections to meet exacting requirements. Simple centrifugal design has 400 less parts.



Another YORK Trail Blazer Concept Proved In Action at *Wyandotte Chemicals Co., Geismar, La.*—Two 6-stage 1880 hp turbine driven tandem compressors supply refrigeration for chlorine production. Five suction connections handle 2 loads of condensing chlorine at 2 temperature levels, a water cooling load and 2 stages of refrigerant cooling.

YORK CORPORATION
Subsidiary of Borg-Warner Corp.
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Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

New-product sales spur R&D increases

	Sales Increase (*Physical Vol.*)		New Products (*Percent of '64 Sales*)
	1960–61	1961–64	
Chemicals	4%	22%	20
Paper & pulp	7	20	12
Rubber	4	18	7
Stone, clay & glass	2	22	13
Petroleum & coal products	3	11	5
Nonferrous metals	3	23	11
All manufacturing	3	20	14

Research & Development Expenditures (Million Dollars)

	Project Work			*New Facilities*
	Actual	Planned		
	1960	1961	1964	1961
Chemicals	741.2	785.7	919.3	123
Paper & pulp	69.1	75.3	93.4	19
Rubber	89.3	93.8	108.8	15
Stone, clay & glass	86.1	90.4	111.2	17
Petroleum & coal products	309.7	319.0	338.1	26
All manufacturing	9,355.4	9,995.6	11,113.6	653

turers plan continued emphasis on modernization through 1964. They indicate that, during 1962-1964, two-thirds of their capital outlays will be for modernization or replacement of producing facilities. The chemical industry, however, indicates that it will continue to stress additions to capacity.

▶**Capacity Increases, Modest**—Reflecting their emphasis on modernization outlays, manufacturers will add relatively little to their producing capacity in the approaching years. This year's increase in manufacturing capacity will be a modest 4%, on the average, with the increases among CPI producers ranging downward from 6% for chemicals and pulp and paper to no increase for the petroleum and coal products industries.

And between 1961 and 1964 manufacturers now plan to add only 10% more to their producing capacity. In the CPI category, total additions to capacity for this period will range from 6% for the petroleum and coal products industry to 14% for the chemical industry.

Significantly, increases in sales volume now expected by 1964 are substantially greater than additions to capacity planned for the same period.

Manufacturers, recovering from a recession, expect that their sales volume for 1961 as a whole will be only 3% greater, on the average, than 1960 sales. Pulp and paper producers, expecting to outstrip other chemical process industries in sales gains this year, envision a 7% increase in sales volume. But gains expected by other CPI producers are definitely more modest.

For the succeeding years, however, sales prospects are considerably brighter, manufacturers feel. They expect to see sales volumes rise an average 20% between 1961 and 1964. Chemicals makers, and producers of stone, clay and glass products, anticipate an even better showing, their sights being set on a 22% increase in sales volume in the three-year period.

If these sales expectations are realized, the margin of excess capacity currently evident in many industries will considerably diminish. And needed additions to capacity could join modernization needs to swell capital outlays in the years ahead.

▶**R & D, Growing**—One of the most striking trends revealed by the survey is manufacturers' growing emphasis on research and development.

This year, manufacturers' spending plans call for almost $10 billion for this purpose. And by 1964, according to current thinking, manufacturers' research and development outlays will be beyond the $11-billion mark.

Among the chemical process industries, this year's R&D budget will range from $786 million for the chemical industry to $75 million for paper producers. By 1964, these industries are expected to spend $919 million and $93 million, respectively.

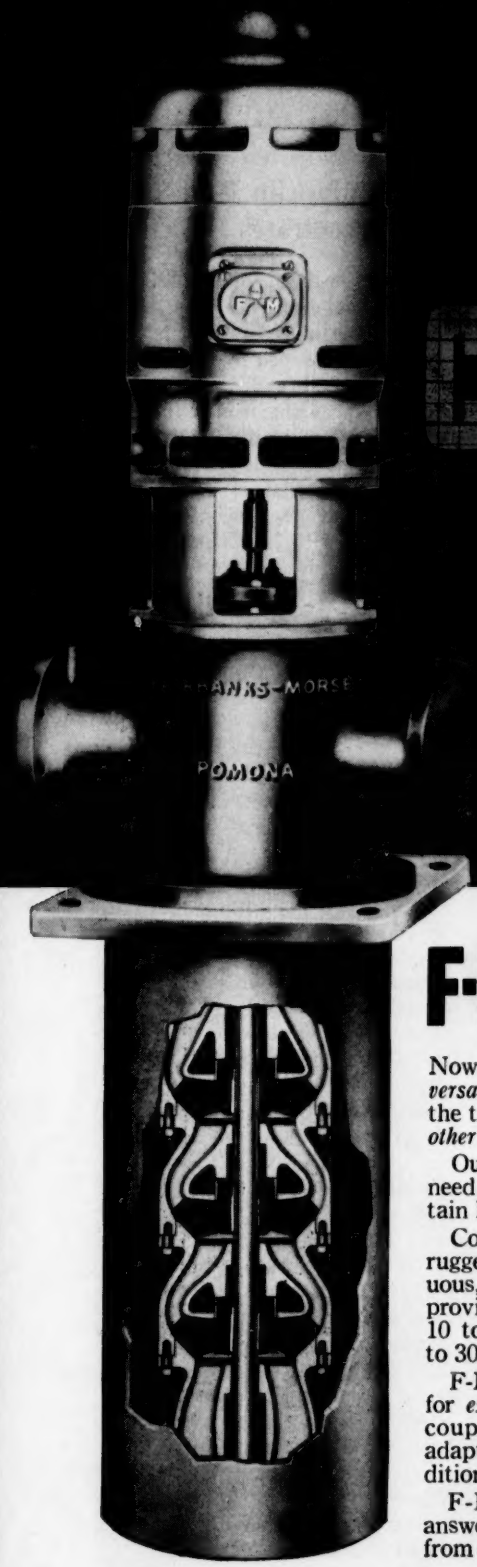
The motive for research and development efforts is clearly suggested by 1960's sales results. Last year, manufacturers derived an average 10% of sales volume from products not produced four years previously—new products that grew largely out of past research and development. And the current heavy emphasis in this area presages a continued flow of new products in the years ahead.

Manufacturers now expect that 14% of their 1964 sales volume will be in products that were not on the market in 1960. New products are clearly of vital importance to chemical producers, who expect 20% of their 1964 sales volume to be in products not produced in 1960.

Among other CPI producers, new products will not play so crucial a role in future sales, but their importance will be considerable. Stone, clay and glass producers count on new products to bring in 13% of 1964 sales volume; paper producers, 12%; rubber producers, 7%; and petroleum and coal products firms, 5%.

An overwhelming majority of CPI firms currently are devoting most of their R&D efforts to development of commercial rather than military products. Well over 90% of CPI research and development is for commercial products.

Most companies expect these R&D efforts to pay off within five years.



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Our unique "pot" principle prevents need for space-taking pits . . . helps attain higher pressures.

Compact F-M Turbine Pot Pumps are ruggedly built for longer life—continuous, trouble-free operation. Each pump provides higher output (capacities from 10 to 30,000 gpm), with pressures up to 3000 psi.

F-M Turbine Pot Pumps are *flexible* for *extra* savings! Their unique, close-coupled turbine design makes them adaptable to changing operating conditions with minimum expense.

F-M Turbine Pot Pumps are the answer to many liquid-moving needs—from clear water to hot or cold, corrosive or non-corrosive, volatile, or non-volatile liquids. They are available with mechanical seals for any pressure range.

Fairbanks-Morse has a quality-engineered Turbine Pot Pump for almost every range of industrial service . . . water supply, air conditioning, water flood, process-pumping. And—Fairbanks-Morse service will help you enjoy continuous pumping operations . . . all the time . . . anytime!

For further information write: Pump & Hydraulic Div.; Fairbanks, Morse & Co.; Kansas City, Kansas.

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Vapor-Phase Process Grows Unique Crystals

Capitalizing on the rapid growth of the semiconductor industry, Merck & Co., Rahway, N. J., is starting construction on a new silicon wafer plant at Danville, Pa. Plant will incorporate a vapor-phase production process developed by Merck; a pilot plant to grow germanium wafers by the identical technique has just gone on stream at the same site.

Merck's process makes p-n junctions directly from the vapor phase, permitting close control of resistivity, thickness and other junction parameters. Conventional semiconductor junctions are made by alloying or diffusion methods.

The new type of silicon wafers are used in epitaxial semiconductor devices, such as long-life transistors for solid-state computers. (Epitaxial refers to the crystallographic orientation and surface of the substrate on which the silicon crystals are deposited.)

To achieve single-crystal growth on a monocrystalline seed, a volatile halogenated silicon compound undergoes hydrogen reduction at 700-1,300 C. Main advantage of this method is that during growth, volatile acceptor or donor impurities can be added, achieving a unique set of crystal properties.

Two versions of freeze-desalting process get tryout

Blaw-Knox recently started up a 35,000-gal./day pilot plant at St. Petersburg, Fla., to test two different sets of equipment for the Wiegandt desalination process (Chem. Eng., June 13, 1960, pp 152-155). At left is a Rotocel (rotating basket) now being run to determine its efficiency in separating ice crystals from brine. This summer, the parallel Wiegandt freezer-melter (right) will undergo similar tests.

Kiln-Within-Kiln Reduces Iron Concentrates Directly

Another process for the direct reduction of iron ore has been added to the already long list of processes. Developed by Allis-Chalmers, the route is called ACAR, can reduce 95% of the iron oxides in ore concentrates to metal.

The process is made feasible by a reduction kiln that is really two rotary kilns in one. The outer cylinder is lined with insulating brick; a concentric inner stainless-steel tube creates an annular space. Both cylinders rotate together; flanges on each end of the rotating tubes press against stationary flanges on feed and discharge hoods.

Pelletized feed consists of magnetite concentrate that contains admixed coal or coke in a greater amount than is needed to reduce the oxides in the ore. The pellets are fed directly into the inner cylinder, where they are in contact with feed gases consisting of oxygen, air, or steam (or a combination of these) and fuel gas.

Passing concurrently with the pellets through the inner kiln, the gases are reformed with the aid of the iron oxide as catalyst, into an atmosphere consisting primarily of hydrogen and CO; these gases then act to reduce the oxide to metal. The unused gases flow back to the annulus where sufficient air is introduced to burn them and hold inner kiln temperature at 1,900 F.

One chief advantage of the system is that the kiln itself is used as a gas cracker or reformer for preparing strong reducing gases, thus obviating the need for an external reducing-gas generator.

A total retention time of 2½-hr. produces easily handled pellets requiring no further agglomeration. These pellets have been successfully melted in a hot blast cupola, with a metal recovery of 90 to 94%.

"Made OF Stainless Steel ...Made BY Jenkins"

And the "BY" is the most important word in that Spec!

Let's talk sense about stainless steel valves.

The material, the metal itself, is pretty much a cut-and-dried matter of *specifications* — selecting the right metal for a particular application. After all, the same alloys are available to *all* valve manufacturers!

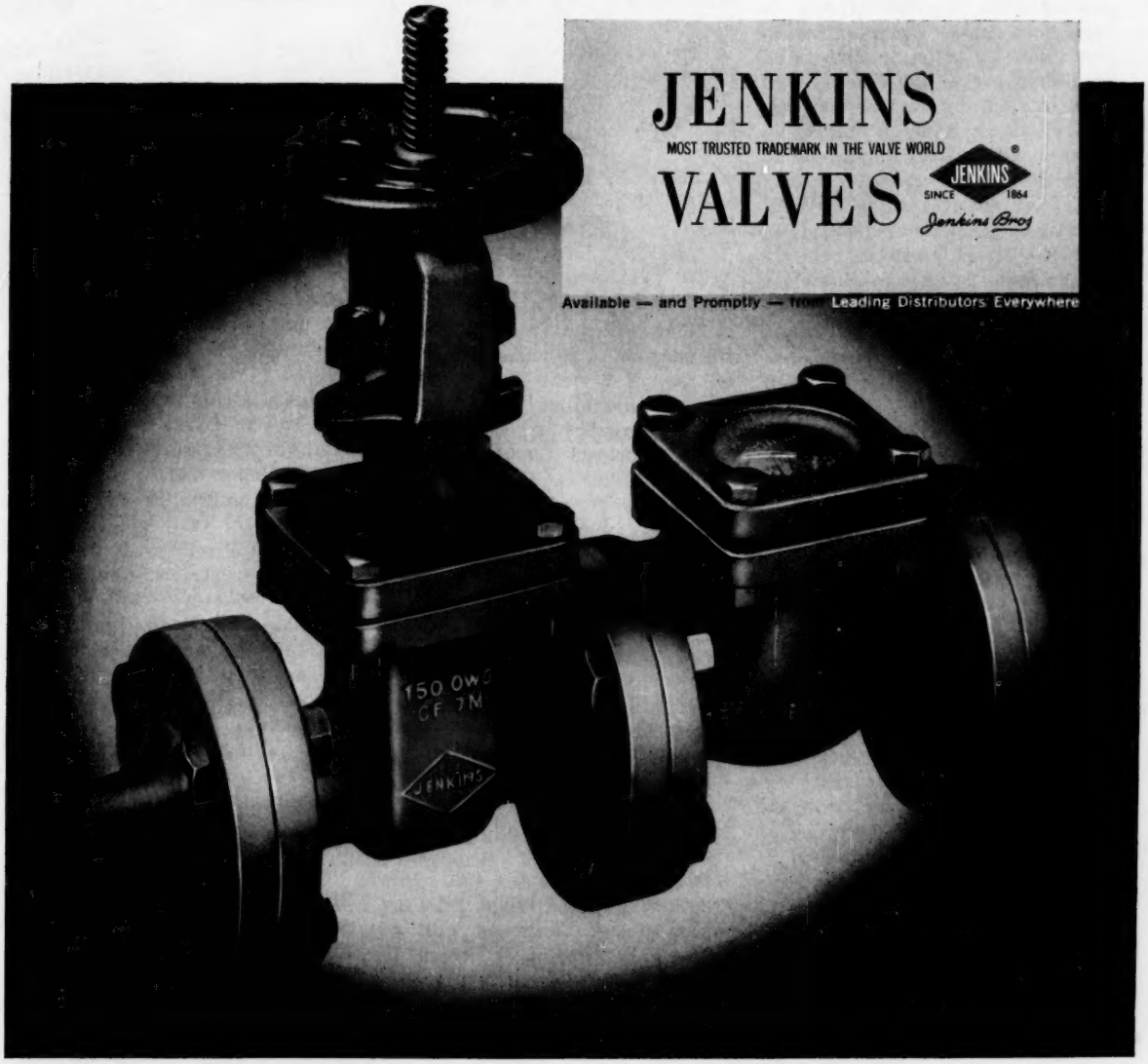
But —

Just as is the case with iron or bronze valves, the basic and essential difference is in the *way* valves are made. *Perfection of castings . . . precision machining . . . sound design . . . painstaking inspection and testing —*

These are the really meaningful, the sense-making factors which impel more and more buyers to specify "BY Jenkins," along with the specification for a particular alloy.

At Jenkins every operation, every process, every test, every worker — all combine to fulfill the traditional (almost 100 years old!) standard of Jenkins quality — the very highest, the *standard* of quality for valves.

SEND FOR CATALOG 59-SS of Jenkins Stainless Steel Valves in types and alloys to fill 99 out of 100 application requirements. All made the Jenkins way to give you the longest, most dependable valve performance money can buy. Jenkins Bros., 100 Park Ave., New York 17.



CPI News Briefs

- Processes
- Plants
- Offices
- Companies
- International

Processes

Cermet powders are being produced by Curtiss-Wright Corp. via a continuous process that has just been patented (U. S. Patent 2,893,859). Technique can also yield metal alloy powders by additional processing. The desired elements are dissolved in a special solvent, then flash-dried to give a powder containing an intimate mixture of the components. Residual solvent is driven off by further heating, and resulting mineral product is reacted with a reducing agent to yield the desired cermet or alloy.

Typical powders made by C-W in a pilot plant at Quehana, Pa., include Monel, Inconel, molybdenum permalloy and tungsten carbide. Powders can be rolled or extruded into finished shapes having physical properties equal to wrought material.

Hypochlorite bleach liquor process has been developed by Hooker Chemical, is now being offered to industry on a royalty-free basis. System produces a semiclarified liquor by passing a lime-slurry and chlorine mixture through a retention circuit where chlorination takes place. Mixture then flows through a liquid classifier. Overflow is product calcium hypochlorite while underflow recycles to lime-slurry feed.

A portion of bleach product actuates a measuring device that signals a controller, regulating the chlorine feed. Advantages claimed for the process are reduction in space requirements, lower installation and maintenance costs.

Pure tungsten has been melted and cast on a commercial scale by Oregon Metallurgical Corp., Albany, Ore. Tungsten, which melts at 6,170 F., is commercially melted by Oremet in an electric-arc vacuum furnace powered by a 40,000-amp. power supply at 40 v. Tungsten castings, up to 220 lb., are made by a centrifugal process. Technique should cut the cost of tungsten parts, which are now made by machining of forged ingots. The older method can produce as much as 900 lb. of scrap for every 100 lb. of useful shapes.

Wood, pressure treated with pentachlorophenol, is claimed by Koppers Co. to be superior to wood treated by other preserving processes, with little increase in cost. Firm's new Cellon process is based on use of liquefied gas in a pressure vessel to get deep penetration of wood fibers. Treated wood is unchanged in color, weight, strength, gluing and working properties. Koppers is now producing pilot quantities.

Plants

Atlantic Cement Co. plans a $64-million, pollution-free plant near Ravena, N. Y., to make 10 million bbl./yr. of cement in giant 600-ft.-long pipe kilns. Some cement will be bagged, but most is slated to be conveyed 7,000 ft. to the Hudson River and poured into ship holds for delivery to East Coast customers.

Lake Charles, La., property owners have approved a $13-million bond issue to finance digging a canal eastward from the present ship channel, thus creating 12 more miles of deep-water frontage at the port city. Present channel will be deepened to 40 ft., widened to 400 ft.

Hercules Powder Co. dedicated its 60-million-lb./yr. polyolefins plant at Lake Charles, La., while construction continued at the same site on a second unit of equal capacity, due on stream in 1962. Highly automated, the just-opened facility will originally turn out polypropylene. This will boost by 175% company's 80-million-lb./yr. potential for high-density polyethylene and crystalline polypropylene, on stream since 1955 at Parlin, N. J.

The Firestone Tire & Rubber Co. has begun producing Diene synthetic rubber at its new, multimillion-dollar facility in Orange, Tex. Capacity is rated at 30,000 long tons/yr. of stereospecific polymer—either Diene (from butadiene) or Coral (from isoprene) rubber—bringing Firestone's worldwide potential for synthetic-rubber production to 281,500 long tons at plants in Orange; Akron; Lake Charles, La.; Pottstown, Pa.; and abroad in Liberia.

Du Pont has placed on stream at Belle, W. Va., an installation that more than doubles the company's existing capacity, at Houston, for methylamines and their derivatives. Due to new production, the company has chopped 30% off its dimethylacetamide price (down to 50¢/lb.). In addition to DMAC, the new Belle plants makes dimethylamine, dimethylformamide and monomethylamine, prices of which may also be sliced.

Shell Chemical Co. has awarded contracts to C. F. Braun & Co., Catalytic Construction Co., and The Ballinger Co. to design and build its multimillion-dollar, 80-million-lb./yr. polypropylene plant near Woodbury, N. J. Facility is due on stream in mid-1962.

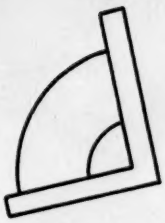
Louisiana Power & Light Co.'s steam-electric power station is on stream 29 mi. north of New Orleans on the Mississippi River. Thought to be the world's first fully automated steam-electric unit, the plant generates 230,000 kw. with three men at the controls, eventually will turn out 2 million kw.

Phillips Petroleum Co. proposes a major expansion of its Great Falls, Mont., refinery, but declines

CPI News Briefs continue on page 200

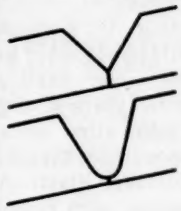
. . . cuts welding costs of fabricating process piping

FEATURES OF *FLOWLINE* FITTING WELDING ENDS ASSURE COST-SAVING PIPING CONSTRUCTION



SQUARE END . . . machine tool cut

CIRCULARITY AND TRUE WALL UNIFORMITY



MACHINE TOOL CUT BEVEL . . . NOT GROUND

We Make Corrosion-Resistant Welding Fittings— *nothing else!*

FINER FITTINGS THROUGH SPECIALIZATION

COST NO MORE THAN ORDINARY FITTINGS

The cost of corrosion-resistant welding fittings is normally only a *small part* of the welding costs of fabricating a piping system. For this reason it pays to use FLOWLINE Fittings.

FLOWLINE Fittings, like all reputable piping materials, are made to A.S.A. and M.S.S. Standards. But—this is only half the story. Due to our methods of production and inspection FLOWLINE Fittings are supplied much closer to nominal dimensions than to industry-standard permitted extremes.

This high dimensional accuracy simplifies alignment and permits constant welding speed to be maintained with uniform penetration. Better, faster connections can be made—resulting in welding cost reduction and sound construction.

For specific evidence of cost savings you can effect by using FLOWLINE Fittings write for Form I-92.

FLOWLINE Fittings are regularly produced of Stainless Steels 304, 304L, 316, 316L and 347, Aluminum, Monel and Nickel, sizes ½" through 24", Schedule 5S through XX Heavy.

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World's Largest Manufacturer of Stainless Welding Fittings

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F-11

Polyolefin copolymers

Ethylene-ethyl acrylate copolymers offer strength and high flexibility.

Two new plastics that equal rubber in flex-cracking resistance, vinyl in stress-cracking resistance, and polyethylene in resilience and elongation, have recently been announced. The first, produced by Dow Chemical, is a copolymer of ethylene and ethyl acrylate. The second, introduced by Carbide, is believed to be a similar copolymer although, in answer to a *CE* question, the company neither confirms nor denies this assumption.

These products, both priced at 32½¢/lb., are aimed at the same markets.

▶**Better Than Vinyls**—Dow's new product, trademarked Zetafin, is available in three formulations that flow more easily than conventional polyethylenes of comparable melt index, thus allowing lower cylinder temperatures obtain faster molding cycles.

According to Dow engineers, this plastic offers other processing advantages over flexible vinyls: there is no thermal degradation during fabrication with Zetafin, and compounding, except for color, is unnecessary. Plasticizer migration, common with flexible vinyls, is no longer a problem, and up to 35% low-cost filler can be added without greatly affecting physical properties.

Dow has evaluated the material with encouraging results for applications such as dolls, toy holsters and saddles, place mats, draperies and table cloths.

The three formulations, Zetafin 30 (melt index of 2.5), Zetafin 35 (another low melt-index material with antiblock additives that minimize blocking tendencies in thingage film) and Zetafin 70 (with a melt index of 18) can be molded on conventional injection molding equipment and are easily purged with low and high-density polyethylene.—**The Dow Chemical Co., Midland, Mich.** 82A

▶**Light but Stiff**—Carbide's plastic, designated Bakelite DPDB-6169, is easily injection molded, blow molded, or extruded in conventional equipment, even though it contains no plasticizers.

At room temperature, the compound has the torsional stiffness of a 90A Durometer elastomeric vinyl. Compared at −25 C., however, it is nine times as flexible. Also, it is four times as flexible as conventional polyethylene at room temperature; three times at −25 C.

According to Carbide, the new copolymer can be regarded as a completely new material rather than a modified polyethylene.

In flex-cracking tests at 0 C., where a typical low-density polyethylene fails at 50,000 cycles and other conventional plastics at less than 250,000, Bakelite DPBD-6169 survives in excess of 2 million cycles. In stress-cracking resistance, company claims it is equivalent to vinyl and far superior to polyethylene.

Thermal degradation problems sometimes encountered with other plastics are avoided because this low-density (sp. gr. = 0.93) copolymer has good heat stability. Suggested applications include such diverse items as industrial bellows, diaphragm pumps, gasketing, and thin-walled and inflatable toys.—**Union Carbide Plastics Co., New York.** 82B

Continued on page 84

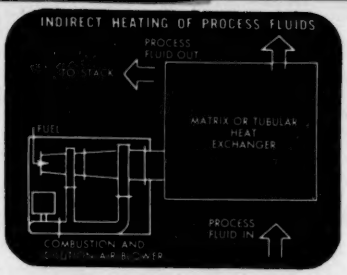
Grafted cellulose dissolves easily in NaOH, KOH

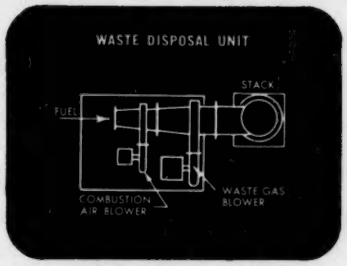
About half the size of cigarette filters, the Ethylose pellets above are the result of ethylene oxide graft on cellulose—a treatment that makes cellulose dissolve easily in common alkalis.

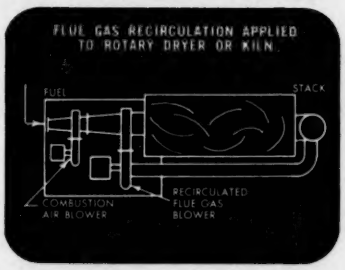
Containing only 4% by weight of ethylene oxide, this grafted compound improves gloss and ink receptivity in paper coatings; waterproofs and strengthens most papers and improves their resistance to heat, oil and grease; makes a good binder for nonwoven fabrics, and can be used as sizing in warp yarns.

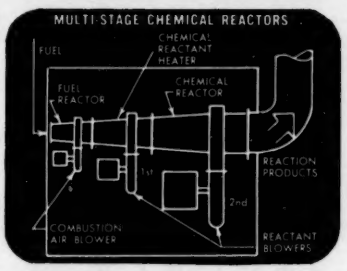
Unlike viscose, the modified cellulose is stable in pelletized form as well as in solution, is more resistant to light, ultraviolet exposures and biological degradation.

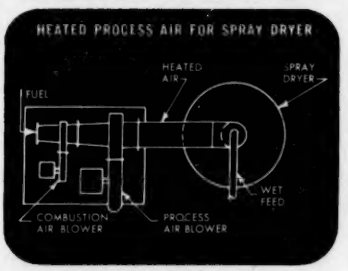
According to Rayonier Inc. officials, the ethylene oxide grafting could eventually be applied to viscose rayon manufacture—obvious advantages would be a drastic cut in the processing time (it takes from 48 to 72 hr. to make viscose, but less than 1 hr. to make the readily soluble Ethylose) and much lower capital investment.—**Rayonier Inc., New York.** 82C

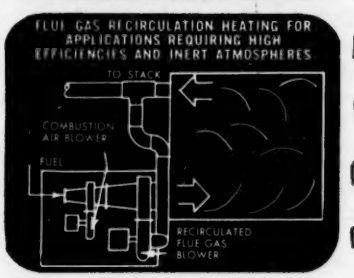






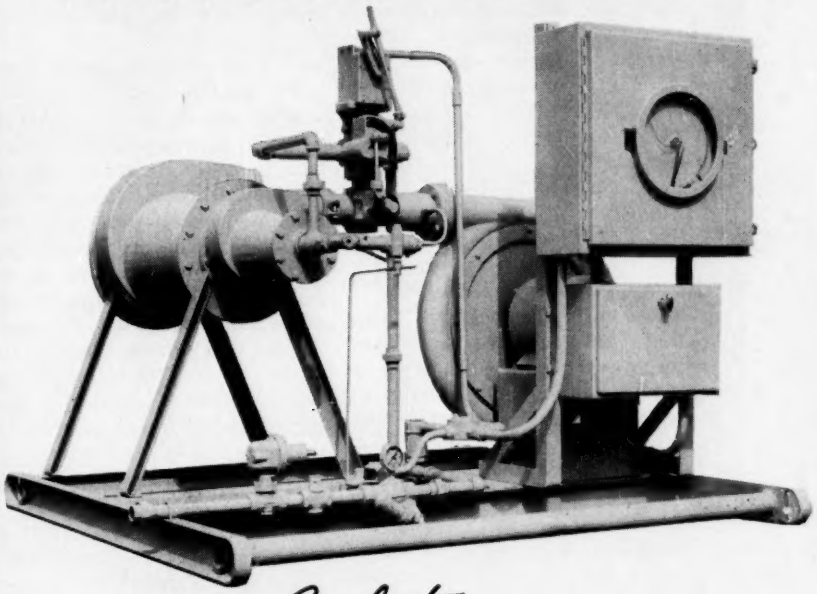






BS&B "Q"-PAK

PACKAGED DIRECT-FIRED HEATERS



The ~~Hottest~~ Coolest Thing in Heaters

HERE'S WHY:

- High heat release, rates up to 10,000,000 BTU/Hr. per cubic foot of combustion volume.
- "Q"-PAK needs no refractory lining even at temperatures of 3000° F. outlet, because outer surfaces are air cooled.
- This completely sealed unit is safe for use in fire hazardous areas.
- Flame stability over a wide range of air to fuel ratios . . . No flame flashback . . . No flame extension . . . Designed to give maximum protection against loss of flame due to overfiring.
- High intensity mixing assures complete combustion: hence produces clean, hot air or gas . . . Provides inert gas generation if required.
- "Q"-PAK operates under vacuum, atmospheric or high pressure situations.
- Burns low pressure, very low BTU content fuels and heats to maximum in minutes (even seconds) from a cold start.
- Completely packaged unit—ready for immediate operation.

That's why we say it is the coolest development in heaters. Just a few of the hundreds of applications are shown here . . . why not find out where "Q"-PAK fits into your process and how it can work for you?

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Silicone-epoxy

Compounds retain flexibility even after prolonged exposures above 450 F.

Capturing the best features of silicone rubber and epoxy resins, a new family of compounds known as Eccosil now makes potting, impregnating, caulking and molding in several electrical applications possible.

The family also includes the lightweight, RTV (room temperature vulcanizing) silicone rubber compounds that have been recently developed by General Electric.

The most interesting compounds, however, are those that incorporate epoxy resins. Two of these are currently available; when fully cured, both have a tensile strength greater than 1,000 psi., a hardness of 70-75 (Durometer Shore A) and low dielectric constants.

Supplied with two catalysts, free-flowing Eccosil 4712 (viscosity 40,000 cp.) cures to a flexible material that, unlike epoxies, remains unaffected by heat aging at 450 F. It also claims excellent adhesion to many materials, without the use of a primer, and is particularly recommended for cable-connector potting and other electrical applications that specify a high-temperature, resilient material.

The other product, Eccosil 4520, is available as a low-viscosity resin (about 50,000 cp.) that can be used as an impregnant and dip coating for transformers, coils and motor stators. Because of its good adhesion to ceramics, metals and plastics, Eccosil 4520 is also reported effective as a surface coating for electronic components and printed circuit boards.—**Emerson & Cuming Inc., Canton, Mass.** 84A

Coatings

Acrylic resin forms a protective film at room temperature.

When applied to metals, glass, plastics, paper and leather, acrylic resin Carboset 511 dries at room temperature to a clear and tough film that withstands even the effects of boiling water. It protects, therefore, such items as highly polished metal sheets during shipment. When the sheets are ready for use, the film can be removed with soap or a mild alkali such as a 2% NH_4OH solution.

The resin, an undisclosed acrylic polymer supplied as a 45% solution in water or alcohol, is compatible with water dispersions of most polymers and even in small amounts favorably modifies the dispersions and solutions of coating materials. In paper coating, for example, Carboset has demonstrated its ability as a clay binder: it is compatible with common clays and its thermoplastic properties make it suitable for calendering.

Because of its flow characteristics and adhesive properties of the dried films, Carboset can also be used in the manufacturing of printing inks and coating for several substrates.—**B. F. Goodrich Chemical Co., Cleveland.** 84B

Methacrylates

New building blocks for copolymerizations are considered for thermosetting coatings.

Available in development quantities, 2-hydroxyethyl methacrylate (HEMA) and 2-hydroxypropyl methacrylate (HPMA) have been proposed as functional group monomers in several copolymerizations and as chemical intermediates.

By solution or emulsion polymerization with other monomers, HEMA and HPMA give long molecules with pendant hydroxyl groups that can then be reacted with bifunctional chemicals to form thermosetting plastics and elastomers.

Both are of particular interest in the development of thermosetting acrylic coatings, wool stabilization formulations, binders for nonwoven fabrics and other products.

HEMA and HPMA are supplied in 1-, 5-, and 55-gal. containers at a standard development price of $2/lb.—**Rohm & Haas Co., Philadelphia.** 84C

Cotton finish

Chemical treatment gives cotton wash-and-wear properties.

Diglycidyl ether is the new chemical treatment that gives wrinkle resistance to cotton fabrics and reduces their tendency to yellow during laundering.

Disclosing this treatment at the American Chemical Society meeting in St. Louis, E. W. Jones of Cone Mills Corp. reported that diglycidyl ether is superior to commercial cotton finishes and is extremely durable to washing.

Most commercial finishes use nitrogen compounds of poor washfastness and "exhibit the undesir-

Newsworthy Chemicals

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Sodium Borohydride Removes Trace Impurities Fast, At Low Cost!

In less than an hour you can reduce 50% of the aldehyde in your glycols without adding any significant costs to your product or process. Sodium borohydride works fast at room temperature and is extremely effective using any of three simple treatment techniques.

In pellet form, sodium borohydride is ideal for fixed-bed purification. In powder or liquid form (SWS) you can add small amounts directly to your process stream. Or, even easier, add borohydride to your glycols while packaging them in drums. The borohydride will "clean up" contaminents while glycols are in inventory or in transit. For re-cycling contaminated glycols, borohydrides are equally effective and easy to use.

At today's record-breaking low prices, if you make or use glycols—especially for plasticizers—it makes good sense for you to get facts now! Complete information, samples and on-the-spot technical service are yours for the asking!

MORE NEWS! MHI Introduces Lithium Aluminum tri-t-Butoxy Hydride! An important new hydride for the reduction of acid chlorides to aldehydes and the stereospecific reduction of steroid ketones to hydroxy derivatives. Information and 25G samples* are free.

*Shipped express collect

PIONEERS IN HYDRIDE CHEMISTRY

Metal Hydrides Incorporated

306 CONGRESS STREET, BEVERLY, MASSACHUSETTS

able property of retaining chlorine, which upon the application of heat, produces tendering and yellowing of the fabric."

Although the mechanism by which chemical treatments impart crease recovery to cellulosic fabrics is not fully understood, Jones points out that chemical cross-linking is a basic requirement. Cross-linking by finishes based on diglycidyl ether could make cotton competitive with the large number of synthetic fibers that give garments wash-and-wear and muss-resistance properties.—**Cone Mills Corp., Greensboro, N. C.** 84D

Refractory

Practically waterproof, new bricks withstand up to 2,800 F.

Reported as extremely resistant to hydration, Hi-Mag is a basic refractory brick for lining the subhearth areas of open hearth and electric steel furnaces.

With a 95% magnesia content, this high-density brick wards off the damage caused by moisture from newly rammed bottoms, remains unaffected by condensation of water when furnaces are cooled, or water accumulation from leaks in the water-cooled sections of steel furnaces.

When tested, Hi-Mag brick was unaffected after 15 hr. in an autoclave saturated with a 100% steam atmosphere at a pressure of 80 psi. Standard ASTM hot-load tests also showed that the brick maintained its refractory properties at temperatures up to 2,822 F.

Another advantage is found in Hi-Mag's low content of chromic oxide (0.8%) and iron oxide (0.6%). If present in larger amounts, these tend to destroy magnesia bricks in subhearth areas because of their reaction to alternating oxidizing and reducing atmospheres.—**Kaiser Refractories & Chemical Div., Kaiser Aluminum, Oakland, Calif.** 86A

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 231)

Synthetic fabric

Nonwoven, mechanically bonded fibers make feltlike fabric.

Dubbed Fiberloc, this new fabric has its fibers bound by a technique described as radically different from that of conventional felting processes. Any man-made fiber, or combination of fibers, can be fabricated into Fiberloc, although it's now being offered only in Dacron, Orlon, Arnel, nylon, viscose, acetate, and polyproylene. Thicknesses up to 1 in. and widths to 108 in. have been attained.

Filtration seems to be a particularly good application for Fiberloc, because permeability can be closely controlled during manufacturing. Furthermore, tensile strengths to 1,500 psi. are possible, temperatures to 350 F. can be withstood, and by proper choice of fiber the fabric will resist acids and alkalis. Precision shapes can be die-cut from the fabric without fraying or unraveling, and the synthetics won't mildew or support bacterial growth.

Other applications have been tested, including insulation, reinforcement, padding, seals and wicks. Almost 50 different types of Fiberloc are now available—in rolls, sheets or precision-cut shapes.—**The Felters Co., New York.** 86B

Insulation

New urethane formulation won't collapse at low temperatures.

It's not easy to find an insulating foam that doesn't shrink at subzero temperatures. The shrinkage usually occurs at or below 0 F. and is caused by collapse of cell walls during the drastic condensation of entrapped gases.

But apparently Nopco Chemical has solved the problem and gone one step further by making a nonshrinking urethane foam at a density as low as 2 lb./cu. ft.

The product, called Lockfoam H-602, claims excellent structural strength and dimensional stability, and exhibits a K factor of 0.13, which is about half that of any insulating material now in use.

Before the development of H-602, shrinkage problems were tackled by increasing the foam's density in order to strengthen cell walls (an over-all density of at least 2.5 lb./cu. ft. was needed for subzero conditions). But this solution was too expensive.

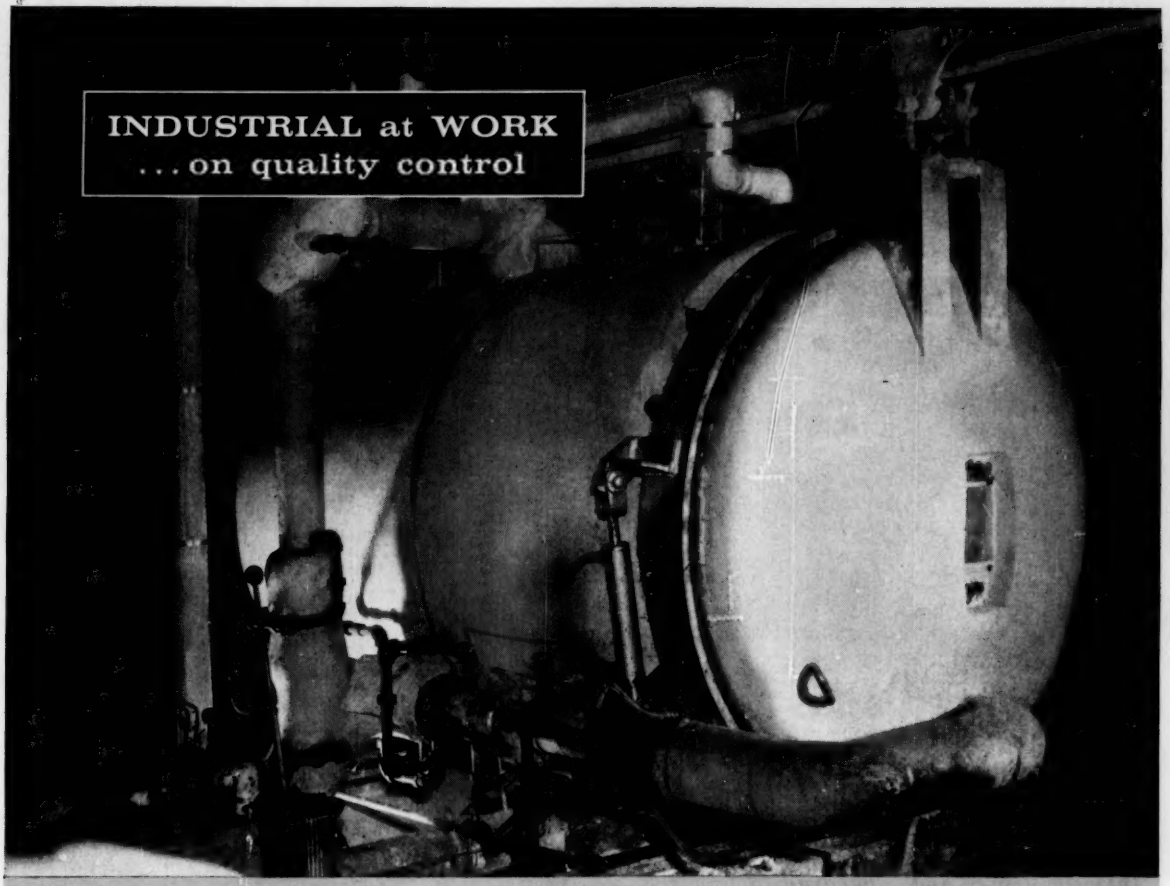
Reportedly, Lockfoam can effectively insulate such items as freezers, frozen food lockers, refrigerated warehouses, highway trailers and railroad cars.—**Nopco Chemical Co., North Arlington, N. J.** 86C

Briefs

Phosphate insecticide, Dibrom, filters out the human hazard factor of phosphates, while maintaining and stepping up quick-kill action towards more than 130 species of insect pests.—**California Chemical Co., Richmond, Calif.** 86D

Silicone spray, Mold-Slic, releases common plastics from molding surfaces after curing. Fume-free, this aerosol keeps molds cleaner and makes possible complicated design work. Product is recommended for acrylics, diallyl phthalates, epoxies, phenolics, polyesters, polyethylenes, polystyrenes, vinyls, other plastics.—**Magnus Chemical Co., Garwood, N. J.** 86E

2, 2, 4 - trimethylpentanediol - 1, 3 - monoisobutyrate, called Texanol, used as starting material in making many PVC plasticizers, can be readily esterified, producing rather high molecular weight compounds with properties that are intermediate between monomeric and polymeric plasticizers. Texanol is priced at 70¢/lb. in tank-car quantities. — **Eastman Chemical Products, Inc., New York.** 86F



How STAUFFER CHEMICAL modernization pays off in improved sulphur quality

Improved sulphur quality and an increase in purification production were Stauffer Chemical's aims in a recent modernization program at their Chester, Pennsylvania operation.

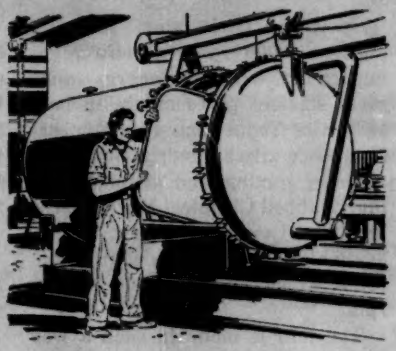
Playing an important role in these now realized goals was this type 122 *Industrial* horizontal filter. Here's how it helped Stauffer to:

IMPROVE QUALITY. Hand skimming of settled carbon from open troughs has been eliminated, permitting major improvements in quality control and optimum carbon removal through filter.

SPEED PURIFICATION. The Industrial filter is designed to handle both ash and carbon in one automatic operation. Raw sulphur is melted, purified and then pumped directly to processing.

In addition, the Industrial filter operation occupies *less* space because with settling eliminated—so is their need for tertiary tanks.

The Stauffer modernization story is typical of how quality-conscious processors throughout industry are turning to *Industrial*-engineered systems to help meet their customer requirements for more, but *better*, products . . . through controlled filtration.

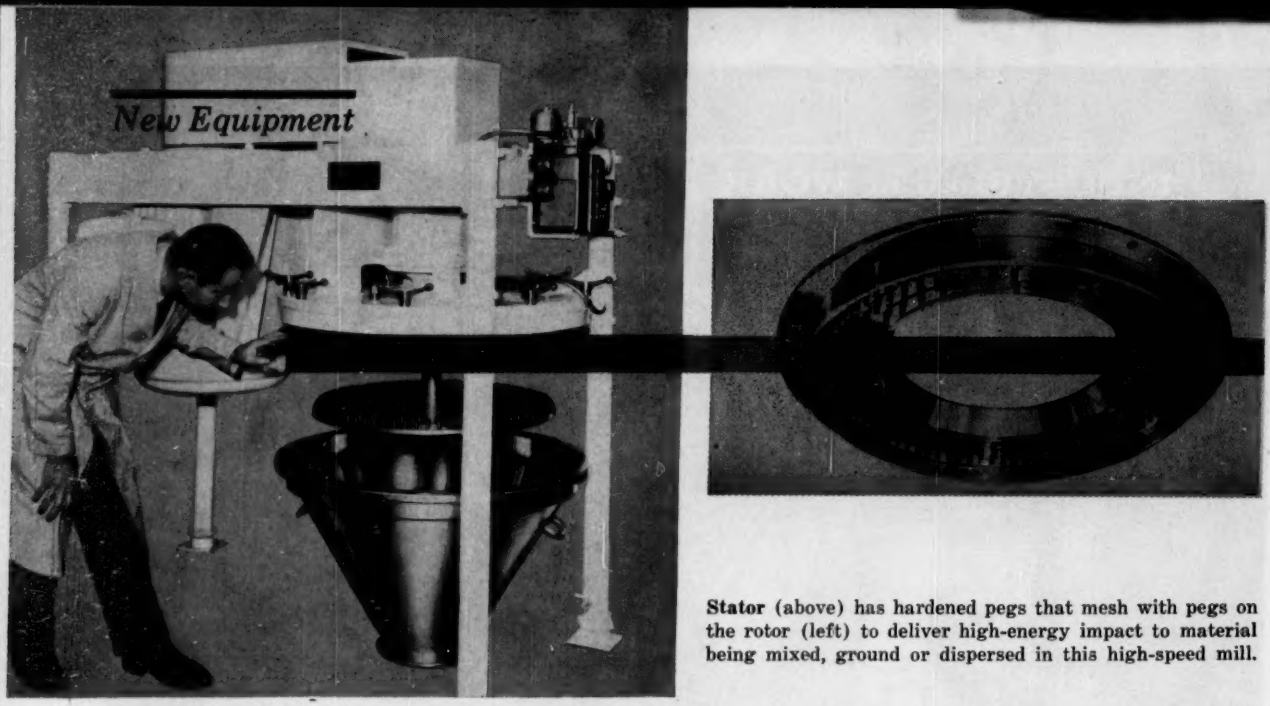


Industrial's "lift out" leaves speed screen replacement and give easy access for filter maintenance. At Stauffer Chemical Company, extra-heavy bolted leaf construction and hydraulic leaf extractor automate operation.

WRITE FOR BULLETIN 122

INDUSTRIAL FILTER & PUMP MFG. CO.
5918 Ogden Avenue, Cicero 50, Illinois

INDUSTRIAL



Stator (above) has hardened pegs that mesh with pegs on the rotor (left) to deliver high-energy impact to material being mixed, ground or dispersed in this high-speed mill.

HIGH SPEED BOOSTS ENERGY OUTPUT OF IMPACT MILL

At 5,000 rpm., impact energy is increased to twice that of former models, shortening mixing time and speeding dispersion of phases.

Operating with rotor speeds as high as 5,000 rpm., a centrifugal impact mill with high energy input gives efficient performance in particle size reduction, deagglomeration, selective pulverization, wet and dry mixing and grain dehulling. Dubbed Chemical Machine, the unit has twice the impact energy available in former models that operated at speeds from 1,500 to 3,850 rpm.

The mill is made in such a way that all parts that contact feed material can be removed and reinstalled in less than 20 min. Thus, lost time resulting from a change in feed materials is held to a minimum, particularly if spare parts are installed and the original ones are cleaned at the operator's convenience.

Many applications have been established for the new machine:

- Dispersing pigments with plastic materials without extra heat and pressure where specifications are strict for degree-of-mixing.
- Wet milling of corn in the starch and adhesives field. High impact principle boosts yields considerably over other methods.
- Processing of materials requiring an inert atmosphere during mixing or grinding.

Material to be processed is fed by gravity into the top of the machine, falling on the flat face of the rotor. Centrifugal force then pushes it rapidly toward the rotor's periphery where it passes through the triple row of impacting pegs on the rotor and stator.

Size reduction, mixing or other operation takes place, then the processed material flows by gravity over the outside perimeter of the rotor and spills into a cone at the bottom, which directs the flow into a container or a subsequent processing step.

For operation under an inert atmosphere, a slight positive pressure can be maintained with the blanketing gas within the machine. Modifications of the shaft seal may soon allow the unit to run under a pressure of several atmospheres at high rpm.

▶**Construction and Specifications**—The mill is built to withstand and contain an internal pressure surge equivalent to a starch explosion (about 100 psi.). Stainless steel construction includes Type 316 for stationary parts, 410 for the rotor and 431 for the impactors.

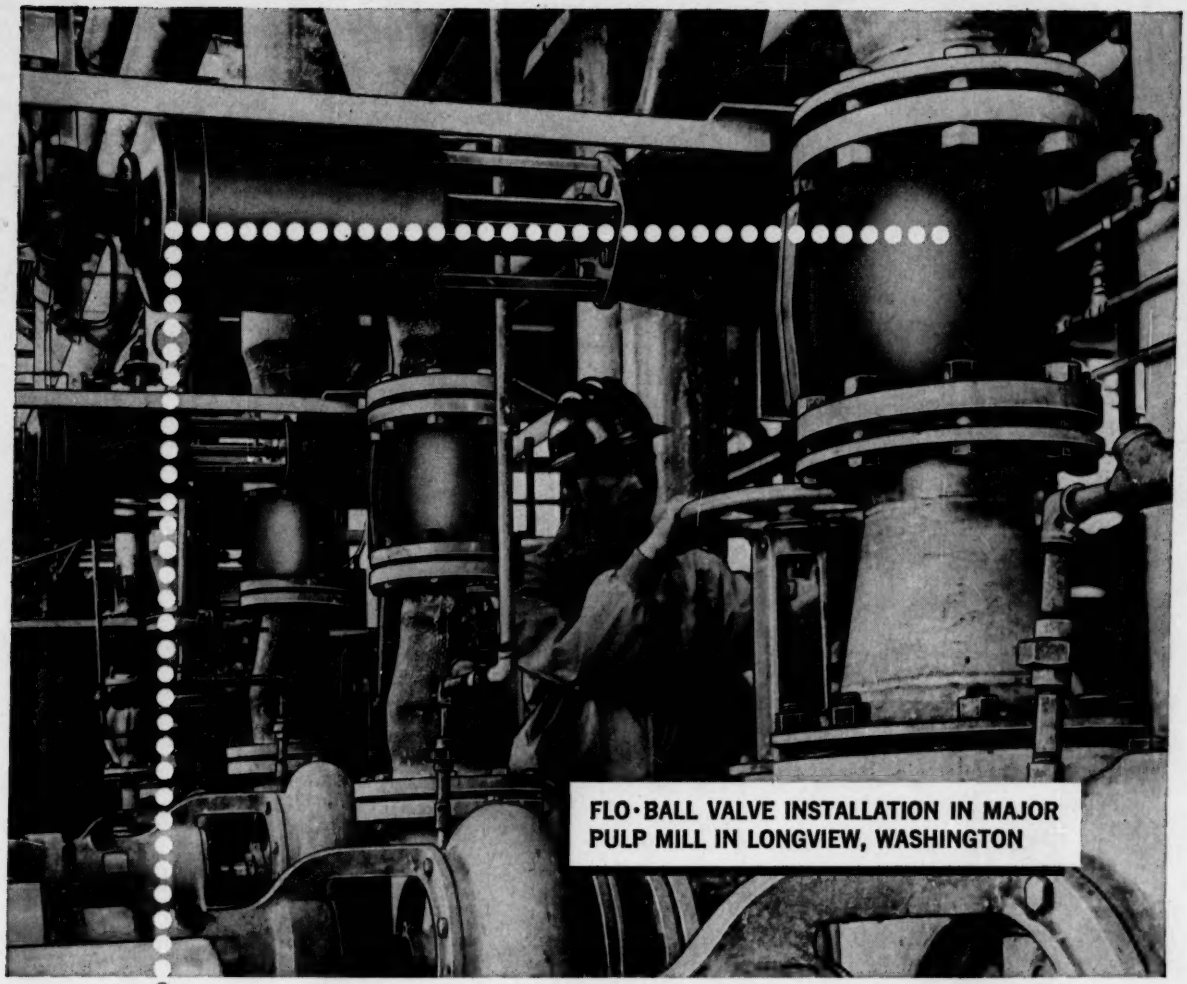
The 27-in. rotor is driven by a 15 to 75-hp. motor, depending on load and rotor speed desired. Capacity, dependent on required impact velocity, ranges up to several tons/hr. Custom-built, the machine costs $10-20,000.—**Entoleter, Inc., New Haven, Conn.** 88A

Granular solids dryer

Wet material is fluidized by hot gas, thus speeding drying cycle.

Suitable for drying granular solids with a minimum of product loss or degradation, a unit called the Fluid-Flo dryer utilizes the fluidized-bed principle to obtain speedy drying.

In operation, material to be processed is fed over a perforated plate. Hot drying gases are pulled through the plate by a suction fan; the gases fluidize the solids so that the bed acts like a fluid and flows horizontally across the plate to a discharge chute. A mo-



FLO·BALL VALVE INSTALLATION IN MAJOR PULP MILL IN LONGVIEW, WASHINGTON

10 months ago these *FLO·BALL* control valves AUTOMATED pulp control!

Not one minute of down-time yet!

Ten months ago one of the nation's largest producers placed ten 6-inch and 8-inch stainless steel FLO·BALL control valves into throttling service in its Longview, Washington plant. Ten months of continuous throttling service, without one minute of down-time, is history-making news in **any** industry.

These FLO·BALL valves have never required maintenance! Never plugged up, jammed or seized. Backlash was dead zero. So was liquid leakage, resulting in complete elimination of stock dewatering.

No maintenance—no down-time—exact repeatability—means dependable automation is now possible in **your** plant.

Characteristics:
Maximum C_V
100:1 rangeability.

Sizes: 2", 3", 4", 6", 8", 10", 12", 150# and 300# ASA.

Controllers: Low pressure pneumatic, hydraulic, electro-hydraulic, electric.

Materials: Carbon Steel, 316 Stainless Steel, teflon seats and seals. Other materials available on request.

Call or write for complete information today.

Hydromatics, Inc.

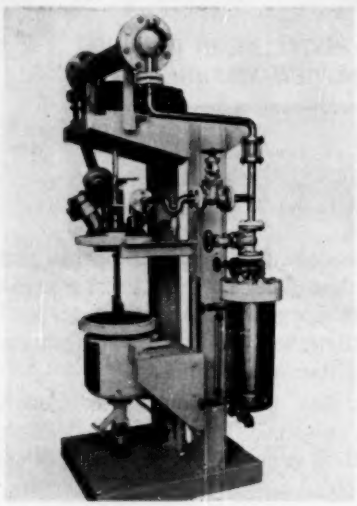
BLOOMFIELD, N. J. • PILGRIM 8-7000 • TWX=BLOOMFIELD, N. J. 120

FLO· BALL

torized air lock in this chute prevents loss of heat and maintains proper suction as it passes the dry solids through to a conveyor.

Partially cooled gases leave the fluidized bed, are drawn through dust collectors where the entrained particles are recovered for recombination with the processed materials, if desired. Clean gas goes out through the suction fan.

Fluid-Flo can also be used as a cooler by passing ambient or cooler air through the bed of material. As a reactor, roaster or calciner, its heated air or gases can be used to trigger a reaction. The device can also dry and size materials simultaneously, the dust or fines carried off being separated from the main stream.—**Link-Belt Co., Chicago.** 88B



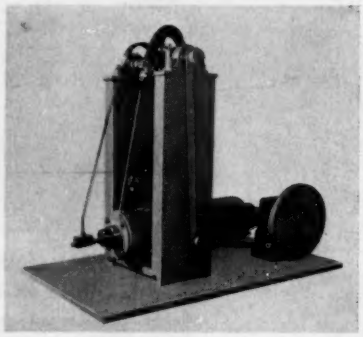
Compact pilot plant

Packaged unit has all essentials for small-scale experimentation.

Mounted on a single base, this stainless steel pilot plant includes a reactor, distillation column, condenser, reflux system, feed tank and vacuum receiver. The reactor agitator is driven by a variable speed assembly and explosionproof motor.

Available in sizes of 5, 10, 20 and 30 gal., the unit can withstand internal pressures of 300 psi. and up. The bottom portion of the reactor is lowered and raised hydraulically to facilitate cleaning and change agitators. Unit is built to ASME code. — **Star Tank and Filter Corp., New York.** 90A

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 231)



Autoclave

Tantalum-lined reaction vessel holds 300 ml. under 5,000 psig.

Although its capacity is only 300 ml., this tantalum-lined reactor operates at pressures to 5,000 psig. and temperatures to 300 C.

Dubbed Pendaclave, unit is externally agitated and said to provide two to three times greater gas-to-liquid contact than conventionally agitated systems. Vessel is supported within its heating jacket at the end of a pendulum arm; as it is swung, it imparts a near-rectilinear motion to its gas-and-liquid cargo. Stroke length is adjustable to 6, 8 or 10 in.

Tantalum, with its high corrosion resistance, lines the inside of the reactor. High-pressure inlet, thermowell and large rupture assembly are other standard features, and a choice between vapor or electrical heating is offered. For safety, the electrical heating jacket can be purged with inert gas. — **Pressure Products Industries Inc., Hatboro, Pa.** 90B

Tubing

Heated hose carries hot oils, asphalts through Teflon lining.

Flexible stainless steel braid is sandwiched between a Teflon outer sleeve and inner lining, forming a tube about the width of a garden hose. Fitted with valve, nozzle or spray gun, and resistance-heated, tubing conveys molten plastics, hot oils, waxes, asphalts, etc.

Either pressure equipment or gravity forces the flow. Power supply leads are attached to terminals at both ends of the hose; source is a variable-voltage, step-down transformer for 115 or 230 v. —**Sta-Warm Electric Co., Ravenna, Ohio.** 90C

Plastic carboy

ICC allows its use for shipping regulated chemicals sans over-pack.

Said to be the first plastic carboy approved by the ICC for transport of regulated chemicals with-

The conduit hat beat 35 years ough, atmospheric corrosion

For 35 years, beneath the suburban passenger cars of the Illinois Central Railroad, Alcoa® aluminum conduit took the toughest torture Chicago's industrial atmosphere could provide.

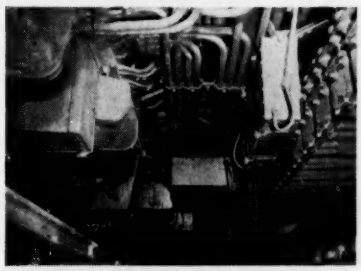
35 of Chicago's blistering summers. 35 of Chicago's blustering winters. Snow. Ice. Rain.

And only the labels were destroyed.

For 35 years this aluminum conduit has been protecting the cars' electrical system, located beneath the cars where they are subjected to most severe service conditions.

The aluminum conduit shrugged off atmospheric attack. Still on the job, it is delivering the same effective protection as the day it was installed.

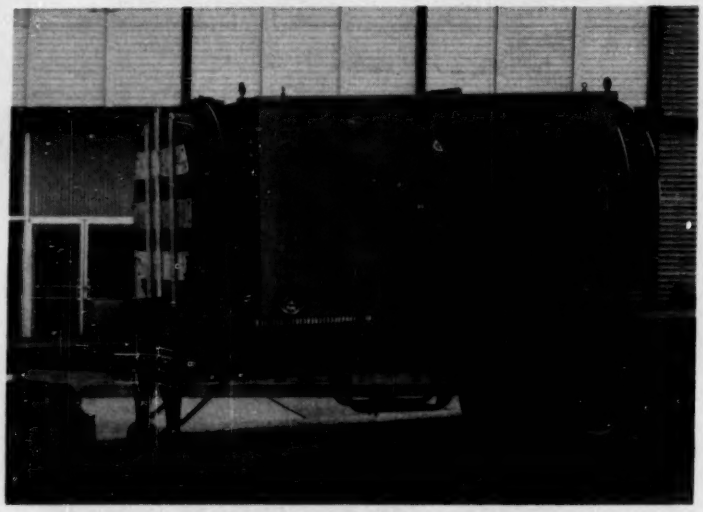
Perhaps you can benefit from Alcoa aluminum conduit's corrosion resistance, lightness and strength in your plant. Contact your Rome-Alcoa representative, or write Rome Cable Division of Alcoa, Dept. 22-51, Rome, New York.



The Alcoa aluminum conduit beneath this Illinois Central car has been in operation since 1926—and only the color has changed.

ALCOA
ROME CABLE
DIVISION

Largest magnetic flowmeter can measure 450,000 gpm.



Weighing 24 tons when filled with water, this giant magnetic flowmeter monitors liquid flow through an unobstructed 6½-ft-dia. tube. Built for the Seadrift, Tex., plant of Union Carbide Chemicals Co., the meter will measure water being pumped from the plant's cooling water basins. Designed to operate fully submerged if necessary, its metering tube is Neoprene-lined stainless steel; and the mile of wire used to develop the magnetic field draws only 35 amp. The "mag" meter was selected for the job because it is smaller, requires less piping and has lower head loss than the other types of meters considered.—**Fischer & Porter Co., Warminster, Pa.** **92A**

Urethane-making machine

Automatic mechanism creates foam using two to eight chemicals.

Dubbed the Model L Urethane Foam Short Run Mixer, this laboratory unit needs only an operator to adjust mixture ratio of from two to eight feed chemicals. Nozzle sprays the mixture into reaction site, while d.c. potentiometers control the separate feed rates into the nozzle. Result: custom urethane-foam formulas can be tested without waste on a moment's notice. By turning a couple of knobs until the resulting foam comes out just right, and then noting the meters' readings, foam can be reproduced on any scale to duplicate the sample.

Gear ratio meters on the Model L series are said to provide an almost infinite set of possible mixtures. Basic machine, complete with operator-controlled demand nozzle, comes equipped with up to eight chemical pots.—**The United Process Machinery Co., Santa Monica, Calif.** **92C**

out an overpack, a 15-gal. unit is made from a copolymer of polyethylene.

The carboy has passed tests of the Bureau of Explosives, Assn. of American Railroads, and the Manufacturing Chemists Assn. Carbon black is added to the plastic to provide color and prevent ultraviolet degradation. Measuring 17¼-in. in dia. and 20½-in. long, the carboy weighs 17 lb.—**Plastineers, Inc., Minneapolis.** **90D**

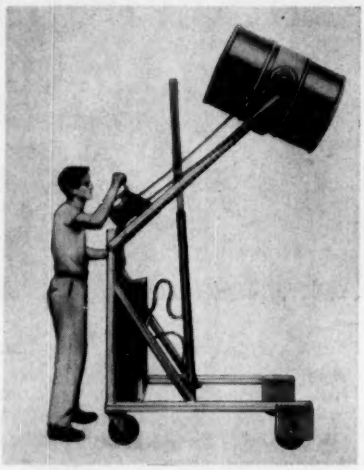
Sonic defoamer

Operating on compressed air, unit shatters bubbles with sound waves.

Defoaming without contamination is possible in a unit that uses an air jet to generate extremely high-intensity sound waves that shatter bubbles and disintegrate foam. No chemical agents are employed.

Each unit has its own air-pressure regulator, so that multiple installations can be made without interaction among individual defoamers. Using air at any pressure above 30 psi., the sonic defoamer knocks down foams created by cleaning chemicals and detergents, pharmaceuticals and many other liquids.

For operation in open or capped tanks, the device can be set to destroy foam either continuously or intermittently when the level builds up to a designated height. During operation, bubbles are subjected to pressures that alternate between more than 30 psi. and near vacuum, 12,000 times per sec. Unit has 5-yr. guarantee—**Teknika Inc., Hartford, Conn.** **92B**



Barrel handler

Portable electrical drum-lifter is compact, operable by one man.

Designed to lift drums 7 to 8 ft. in 30 sec., this portable device can pick up a steel or fiber barrel

New Equipment continues on page 212

In 25 years Brown Fintube Company has become the dominant producer of fintubular heat transfer products for the petroleum, petrochemical and chemical industries. This rapid growth to maturity is traceable to the development of products and ideas that pay off for our customers.

Most of these products are based on our ability to conceive new ways to use the Brown Fintube. We like to call this "fintubility". Numerous solutions to industrial problems have been solved by the Brown Fintube since its extended surface allows the transferring of more heat in a very compact area.

Among the more noteworthy accomplishments of "fintubility" is the perfection of industry's only truly standardized heat exchanger. The Brown unitized heat exchanger system enables any company to meet all duties with one standardized unit. Other cost saving ideas are fintubular tank heaters that accelerate thermal flows for more rapid heating of tank contents; multitube hairpin heat exchangers for high-capacity applications; and low-cost indirect fired heaters for effective heating of gases, vapors and liquids.

If your heat transfer products do not utilize the greater efficiency of the Brown Fintube, may we suggest that you contact us. The people of Brown Fintube are always eager to carry on their research to develop better ways for fintubes to serve everyone. Brown Fintube Company, 300 Huron Street, Elyria, Ohio.

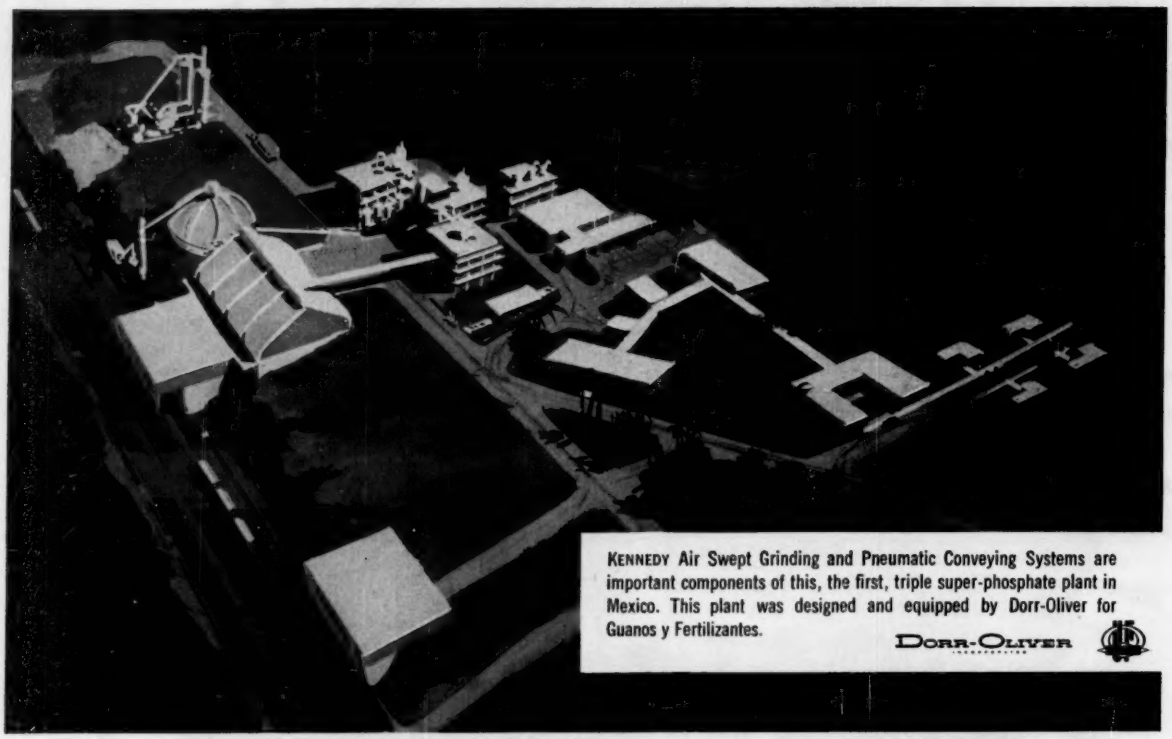
BROWN FINTUBE

SUBSIDIARIES: Brown Metals Inc., Brown Thermal Products Corporation, Brown Aluminum & Chemical Company

FACTORIES AND SALES OFFICES: Chicago • Houston • New York • St. Thomas, Canada • Birmingham, England • Dortmund, Germany • Paris, France • Mexico City, Mexico • Tokyo, Japan.

FINTUBILITY means Fintubes plus Engineering plus Ingenuity

KENNEDY for grinding & conveying phosphates

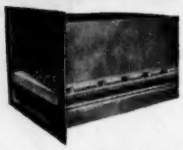


KENNEDY Air Swept Grinding and Pneumatic Conveying Systems are important components of this, the first, triple super-phosphate plant in Mexico. This plant was designed and equipped by Dorr-Oliver for Guanos y Fertilizantes.

DORR-OLIVER

KENNEDY Ball Mills are noted for high tonnage and low cost processing of phosphate rock and other agricultural chemicals:

- Lowest maintenance cost—cannot be jammed or damaged by tramp iron or other foreign material
- No periodic shut downs for wearing part replacement
- Grinding media is replaced without interruption
- High capacity and product fineness remain constant—month after month
- Careful basic design and pressure lubrication assure high mechanical efficiency
- Reliable feed control and overall reliability provide high production with minimum manpower
- Higher capacity in single units—less space and structural steel per ton of capacity and lower initial investment.



KENNEDY AIR-FLOAT Conveyors provide trouble-free air-gravity conveying of dry materials:

- There are no moving parts—nothing to wear—nothing to maintain
- Only small volumes of low pressure air are needed—uses less power
- Operates quietly—has high capacity—requires little headroom
- The conveyed materials are completely enclosed—there is no dust
- Permits flexible design—directional changes are simple
- Can be made from corrosion resistant alloys
- Eliminates lubrication, complicated gears, belts and chains, spare parts and down time for maintenance.

Consult KENNEDY for further details. Let us show you the many advantages KENNEDY equipment can offer you.

KENNEDY VAN SAUN

MANUFACTURING & ENGINEERING CORPORATION

405 PARK AVENUE, NEW YORK 22, N.Y. • FACTORY: DANVILLE, PA.

Primary & Secondary Gyratory Crushers • Jaw Crushers • Roll Crushers • Impact Breakers • Hammer Mills • Rod & Ball Mills • Kilns • Dryers • Screens • Mechanical & Pneumatic Conveyors • Complete Crushing, Lime, Cement & Carbon Paste Plants. KENNEDY Research & Testing Service.

ONLY VISIBLE BLADES GIVE YOU SAFETY YOU CAN SEE!

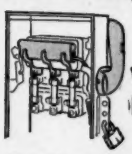
Square D Company,
Mercer Road, Lexington, Kentucky

• The men who pull the switches will tell you what can happen when a switch, *believed* to be open —*isn't*. A lot of things can happen—and every one of them is bad. Personnel safety is in jeopardy. Motors can single-phase. Machinery and work can be damaged. Down-time can skyrocket.

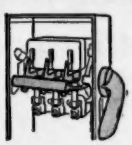
Doesn't it make sense to insist on Visible Blade construction which gives you a road block against any of those possibilities? Doesn't it make equally good sense to insist on the safety switch which gives you that construction—plus a lot of other performance advantages? Evidently it does, because *Square D switches have never been out of first place in more than 50 years!*

They cost no more...why settle for less?

Extra Safety with Square D's Handle Design



WHEN IT'S UP
IT'S ON!



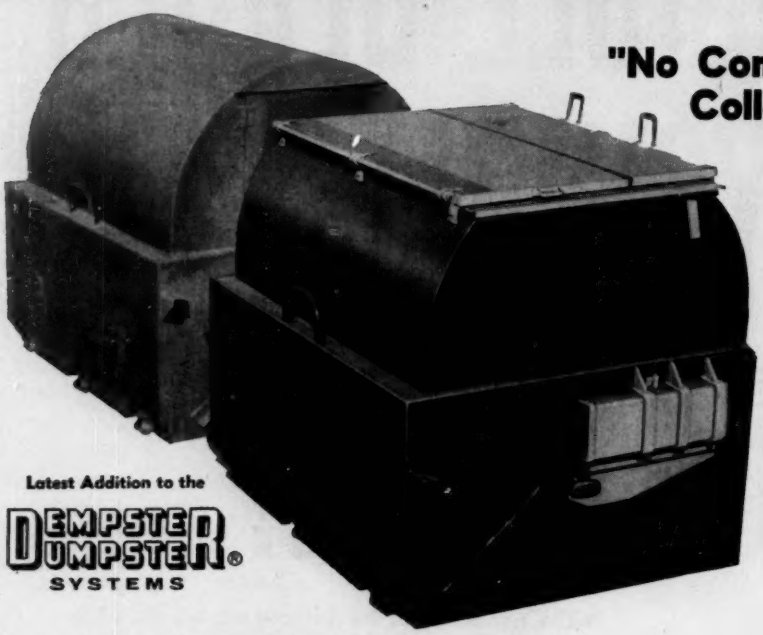
WHEN IT'S DOWN
IT'S OFF!

Handle is integral part of switch, not cover. When door is opened, handle remains attached to switch. Eliminates hazard of false handle indication or defeat of padlock provision. When it's padlocked, it's locked!

SQUARE D COMPANY

wherever electricity is distributed and controlled

New SUPER DUMPMASTER Handles Converted DUMPSTER Containers...Beats Long-Haul Problem



Latest Addition to the DEMPSTER DUMPSTER® SYSTEMS

"No Container Haul System" Collects Refuse on Spot

If longer trips to disposal areas have raised your operating costs, a small investment in conversion kits protects large investments in DUMPSTER containers. The Super DUMPMASTER handles converted DUMPSTER containers up to 12 cu. yd. and all DUMPMASTER containers one thru 12 cu. yd.

Owners of DEMPSTER-DUMPSTER Systems who now face long haul problems due to movement of disposal areas may now convert from their present "container haul" system to the new SUPER DUMPMASTER "no-container-haul" system without abandoning their investment in DUMPSTER Containers.

The SUPER DUMPMASTER makes its rounds to each converted container, mechanically empties the contents into its 30 cu. yd. packer body and compacts the material to a fraction of its former volume with the 85,000 lb. force of its packer plate. Rather than haul each container to the disposal area, the SUPER DUMPMASTER carries the contents of many containers on each trip, cutting collection costs drastically.

Mfd. Only By DEMPSTER BROTHERS Inc.

Write Today for FREE BROCHURE

DEMPSTER BROTHERS Inc.

DEPT. CE-5, KNOXVILLE 17, TENN.

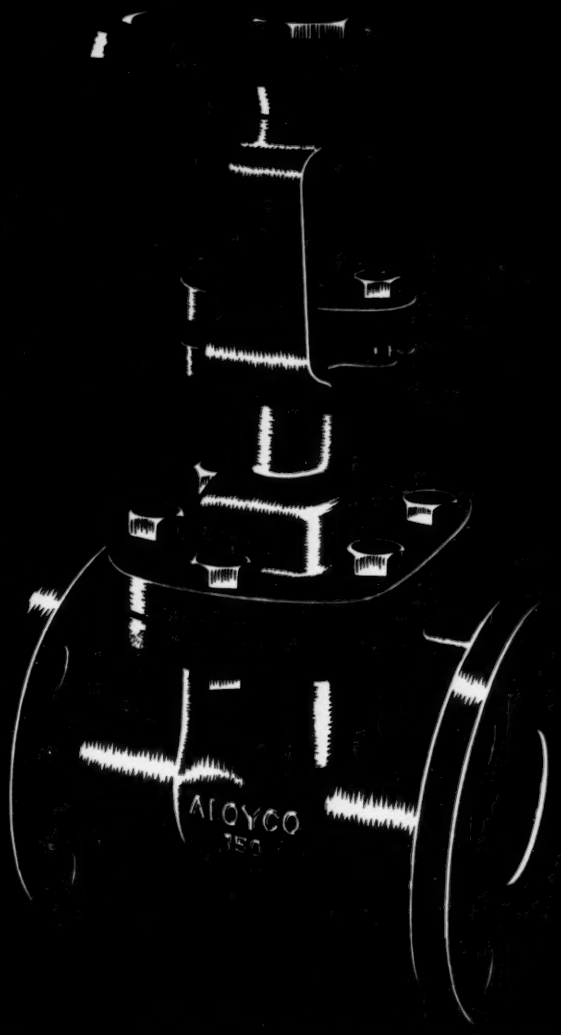
The SUPER DUMPMASTER engages container.

Clearance arms carry it toward hopper opening.

Container is rotated, emptying contents into the compaction body.

we make

...nothing else



ALOYCO 111 Gate Valve for 150 lb. service features double disc ball and socket wedges. They are free to rotate and are non fouling in any position which insures tight closure. There are Aloyco valves and alloys designed for every type of corrosive service.

SPECIALIZATION! Isn't it reasonable to believe that the one company with experience, facilities, research and service all devoted to a single product is your best source of supply? The modern Aloyco foundry, for example, is designed to produce one end product only...pressure tight Stainless Steel Valve Castings of the finest quality.

ALLOY STEEL PRODUCTS COMPANY

LINDEN, NEW JERSEY

Longer Lasting
ALOYCO
VALVES
FIT IN CORROSIVE SERVICE

FILTER FABRIC QUIZ

How would you solve these filter fabric problems?

PROBLEM:

You're a soap manufacturer. You wish to filter foreign matter from oil and glycerin. What filter fabric would you use?

SOLUTION:

Closely woven cotton duck has withstood six months of this arduous service. For even longer life, nylon fabrics are recommended.

PROBLEM:

You're a dyestuffs manufacturer. You wish to separate a dye intermediate from a sulphuric and hydrochloric acid solution at 45°C. What filter fabric would you use?

SOLUTION:

A spun dynel fabric with high chemical resistance is both dependable and durable for this highly corrosive process.

PROBLEM:

You're a ceramics manufacturer. You wish to filter clay slurries. And the filter fabric must have good release characteristics and resist mildew and bacteria growth. What filter fabric would you use?

SOLUTION:

A tough fabric of filament nylon is sleek enough that the filter cake drops away at the touch of a scraper—and so durable that fabric life is multiplied many times.

PROBLEM:

You're a pigment processor. You wish to filter titanium dioxide from strong acid solutions with vacuum-type filters. What filter fabric would you use?

SOLUTION:

A fabric of filament Dacron*, highly resistant to mineral acids, provides smooth cake discharge and long service for maximum operating economy.

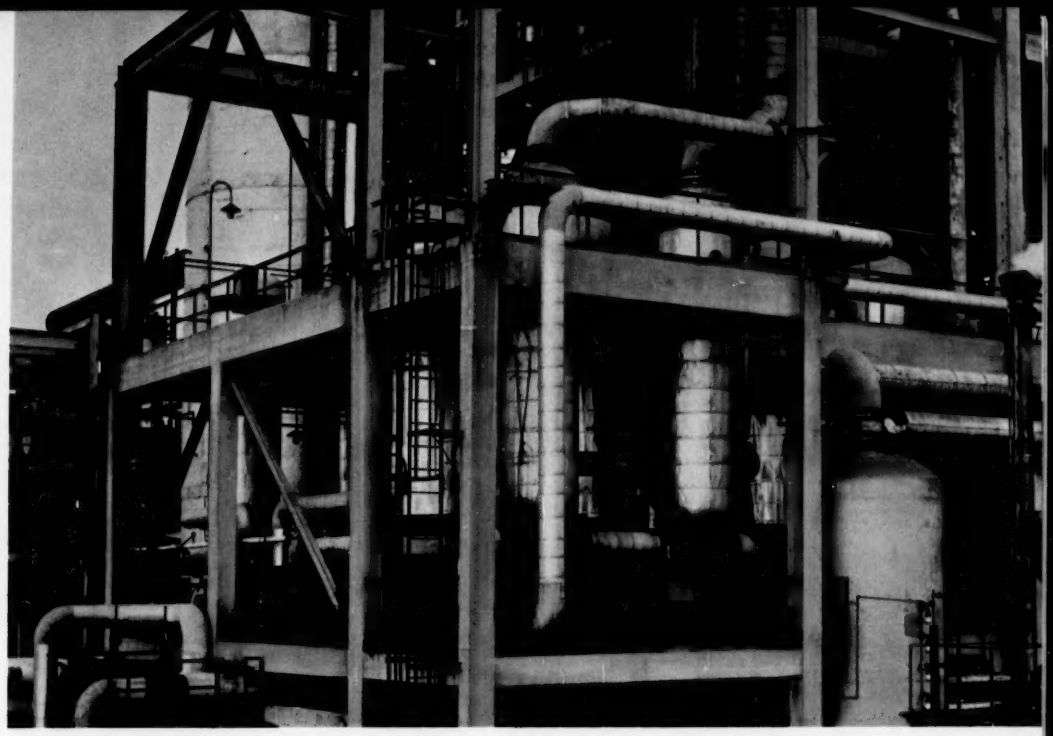
Each of these solutions is but one of many ways to solve these problems. For, as you know, countless factors help determine a filter fabric's performance—fiber, yarn, weave, count and finish, to name just a few. Selecting the most effective and economical filter fabric for a particular job is a very complex matter. And you need the assistance of a specialist—like the specialists who distribute Wellington Sears fabrics. These distributors are experts in the field of industrial fabrics—and always ready to lend a hand in helping solve your problems. For their names, and a free copy of our illustrated booklet, "Filter Fabric Facts," write Dept. L-5 today.

*DuPont trademark for its polyester fiber

WELLINGTON SEARS

FIRST IN FABRICS FOR INDUSTRY

Wellington Sears Company, 111 West 40th St., New York 18 · Akron · Atlanta · Boston · Chicago · Dallas · Detroit · Los Angeles · Philadelphia · San Francisco



Another heat transfer problem solved by Wolverine Trufin® Type S/T

THE LOCATION..... Humble's Bayway Refinery, Linden, N.J.

THE SERVICE..... Gas oil feed for fluid catalytic cracking unit.

TUBE SIDE FLUID..... Cat fractionator slurry recycle.

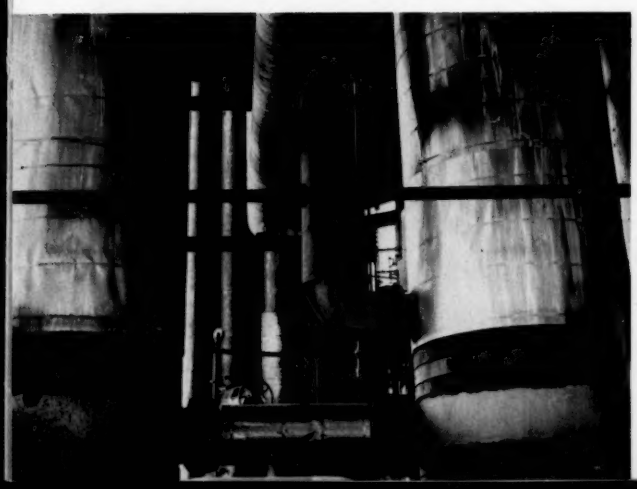
THE EQUIPMENT..... Eight 48" I.D. shell and tube heat exchangers.

THE PROBLEM..... Increase heat duty in transferring heat between two process streams.

THE SOLUTION..... The heat exchangers were retubed with Wolverine Trufin Type S/T —the integrally finned heat exchanger tube. In this case the tubing specified was 19 fins to the inch low carbon steel.

THE RESULT..... Extended surface Wolverine Trufin Type S/T brought about the desired increase in heat duty—without any modification whatsoever to the existing exchangers.

THE REASON..... See explanation on reverse side of this page.



WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. M, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

How to shrink plant costs and boost plant production

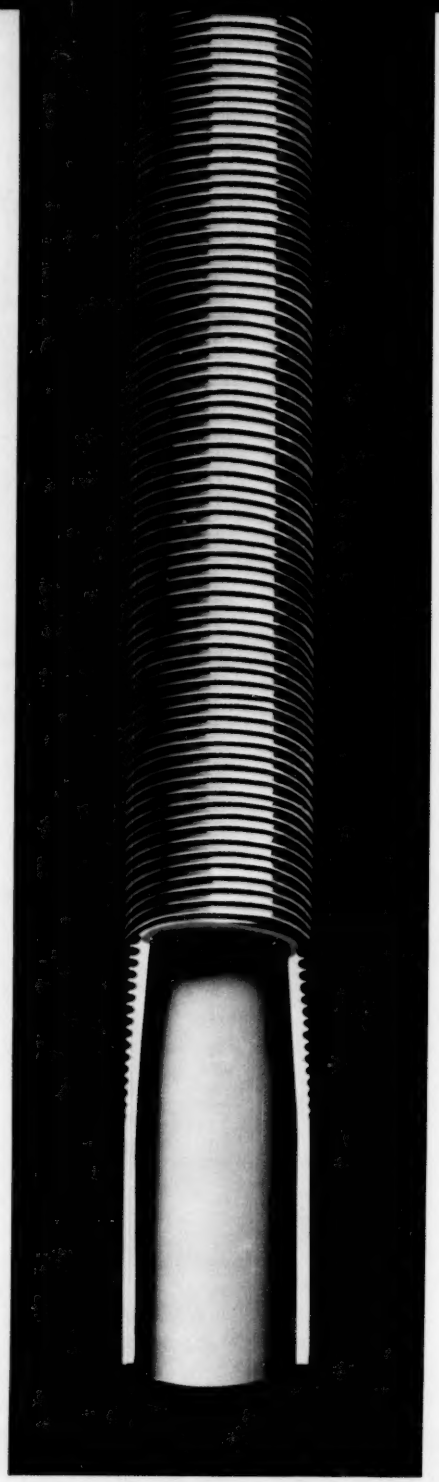
Before you design new heat transfer equipment or retube old—get the Wolverine Trufin story—discover how this extended surface tube can help you *shrink* plant costs and *boost* plant production.

The explanation, of course, is found in Type S/T's integral fins which increase the outside heat transfer surface by as much as 2½ times over a length of bare tube of similar size.

As a result, more BTU's are transferred per foot of tube. Direct tube costs are reduced as are fabrication material and labor costs. In addition, because there is no increase in overall unit size and weight, Trufin-tubed units permit savings in valuable space and require less structural support.

These are some of the reasons why Wolverine Trufin Type S/T has been chosen for applications of the type described on the reverse side of this page. They are also the reason we suggest that you get the Trufin story —NOW! Just "Ask Your Wolverine Tube Salesman—HE KNOWS."

Write today for a free copy of the Trufin Comparison Costs Book.



WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
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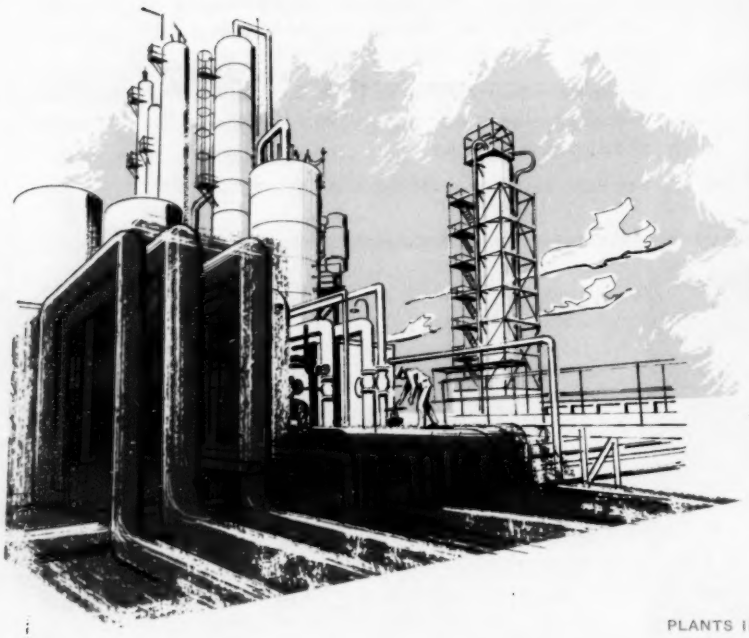
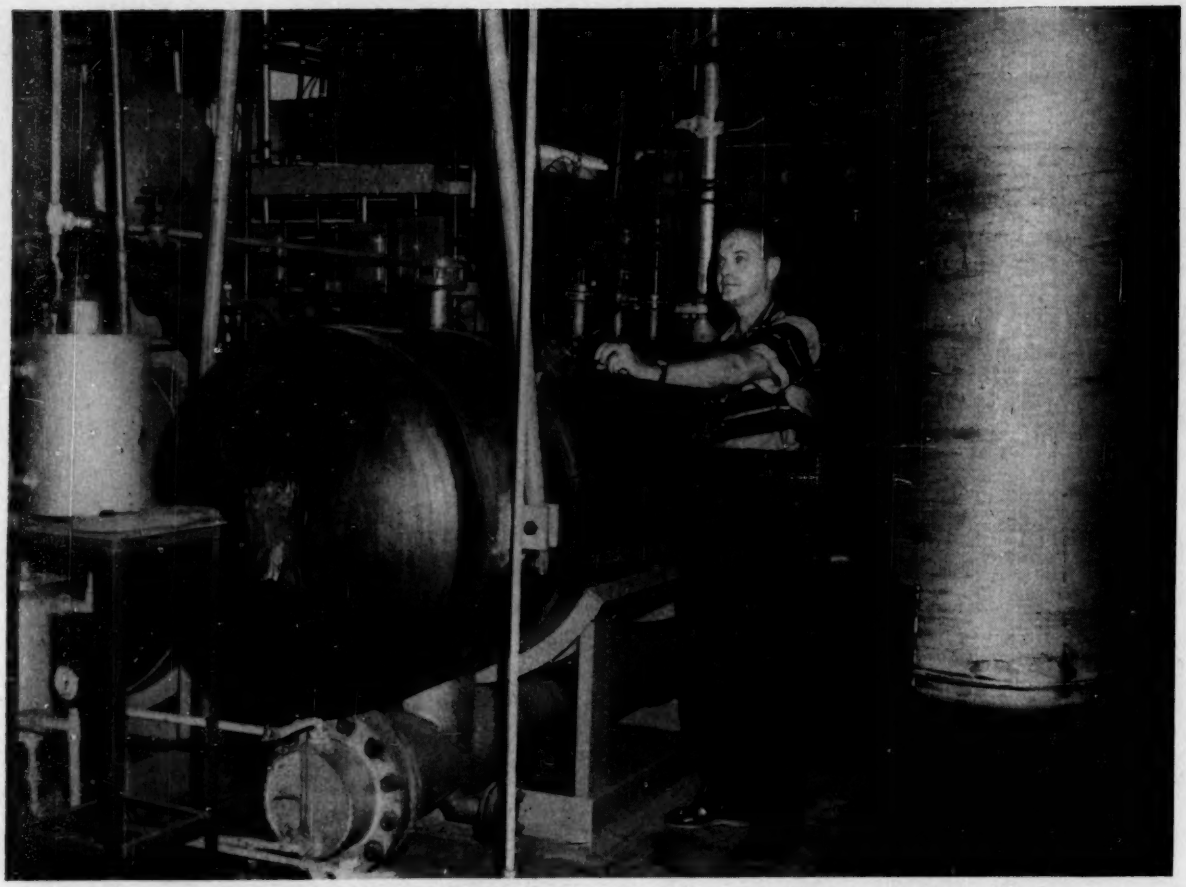
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals



PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES



Stress-corrosion cracking is prevented by the use of Monel alloy for this chloride still at Halocarbon Products Corporation, Hackensack, N. J. Still separates intermediate required in the production of chlorofluorocarbons. It was fabricated by Stainless & Steel Process Equipment Company of Whippany, New Jersey.

The still that succeeded—because Monel doesn't crack when stressed in chlorides

This is a Monel* nickel-copper alloy still with 2½ years of chloride separation behind it, and many more ahead.

The previous still developed stress-corrosion cracks and failed in just about a year... even though made of an alloy with a good record of resistance to generalized chloride attack.

An insidious form of corrosion

Stress-corrosion accounts for many somewhat mysterious premature failures that have occurred in equipment handling chlorides.

Fortunately such failures *can* be prevented. First step is to pinpoint the conditions in your own plant that favor stress-corrosion attack. In this respect, the rule-of-thumb guide at the right may prove helpful. Second step is to use high-nickel materials, such as Monel alloy, for endangered equipment.

Laboratory tests show that resistance to cracking in chloride solutions increases with nickel content. Alloys containing at least 42% Nickel appear to be immune to stress-corrosion cracking under most conditions.

Monel nickel-copper alloy also provides outstanding resistance to generalized corrosion by chlorides. What's more, Monel alloy is readily available and easily fabricated and welded... entirely practical and widely used for pumps, piping, coils, pressure vessels and other equipment. For expert advice regarding specific applications, write:

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17 West Virginia

What every engineer should know about Chloride-Ion-Stress-Corrosion Cracking

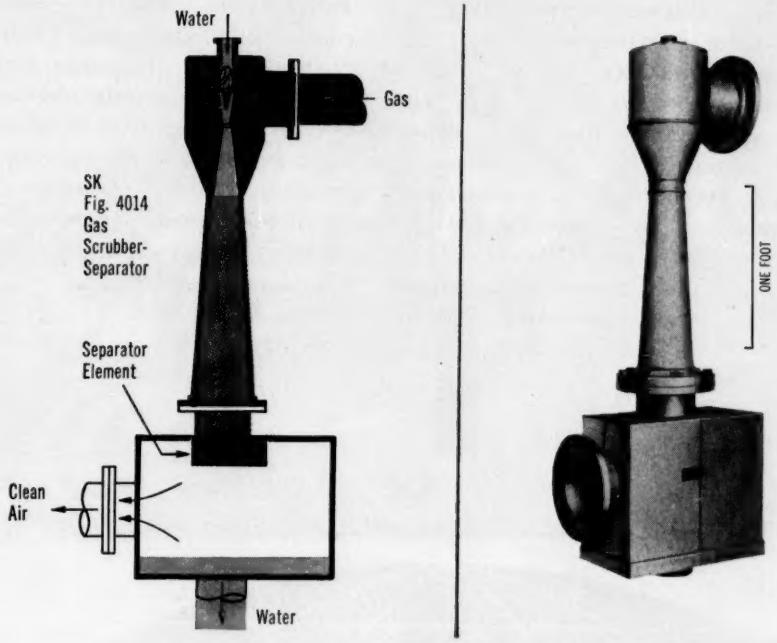
Cracks . . . large, straight or branched, usually transgranular but may be intergranular.

Causes . . . It is best explained as an electrochemical mechanism with crack initiation being related to the available oxygen, specific concentrations of the chloride ion, and the stress level.

Potential . . . Stress-corrosion cracking has been observed in engineering materials that have been cold worked, rolled, welded, periodically wetted and dried. It may occur at stresses as low as 2000 psi; water containing as low as 50 parts per million chloride; at temperatures as low as 100° C.

MONEL.®

SK Introduces New Ultra-Efficient "Packaged" Gas Scrubber-Separator



■ Better performance than ever before possible with ejector-venturi type scrubbers is offered by a new SK unit called the "Fig. 4014 Gas Scrubber-Separator." ■ The "Fig. 4014" combines the familiar SK ejector-venturi gas scrubber with a new separator which, in field tests, has reduced liquid carryover to an almost unmeasurable 0.00002 gal. per 100 cfm. ■ The new unit is compact. The 4 inch size shown measures less than 3 feet in overall height. It can be made in almost any suitable material. Initial and operating costs are low. Popular sizes are carried in stock — scrubbers in cast iron, Haveg, PVC, and stoneware; separators in fabricated steel. ■ Separators can be ordered individually for use with SK Gas Scrubbers. For information, request Bulletin Supplement 4R.

Schutte and Koerting
COMPANY

Manufacturing Engineers Since 1876 / *2217 State Road, Cornwells Heights, Bucks County, Pa.*

PHONE: MERCURY 9-0900 TWX: 69-'U'

The Temperature Control Powered by the

IRREPRESSIBLE FORCE OF MERCURY—

for Accuracy with Rugged Dependability

All Partlow temperature controls are directly and positively actuated by mercury, the metal in liquid form whose reaction to changes in temperature is as predictable as it is powerful.

Unlike delicate electronic controllers, the mercury-actuated Partlow requires no outside power source. No amplifiers. No finicky levers. And no "babying"! With a Partlow you can be sure of getting accurate, dependable control even under extreme conditions of shock and vibration.

Mercury-actuation makes possible maximum design efficiency and simplicity too. The Partlow has fewer parts to go wrong. And fewer service problems (with less "down" time) should trouble occur. You can replace the thermal element of any Partlow control instantly, right at the job site, without recalibrating, fitting or factory adjustment.

Whatever the process or application, you'll find a Partlow temperature control to fit it dependably, economically, *precisely*. Mail coupon today.

See Partlow Section in Chemical Engineering Catalog

PARTLOW

TEMPERATURE CONTROLS

World Export:
Ad. Auriema, Inc., 85 Broad Street, New York 4, N. Y.

THE PARTLOW CORP., Dept. E-561
NEW HARTFORD, N. Y.

Please send condensed Catalog of Partlow temperature controls and allied equipment for industrial heating and refrigeration.

Name and Title .....

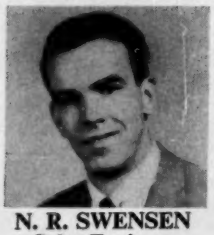
Company .....

Address .....

City and State .....

.....

National Carbon representatives expand your engineering force



N. R. SWENSEN
Sales Engineer

Mr. Swensen is National Carbon's field sales engineer for chemical products in the State of Ohio, with headquarters in Cleveland.

As a member of National Carbon's application engineering group, he was active in the design and development of chemical processing equipment, particularly entrainment separators and hydrochloric acid absorption systems.

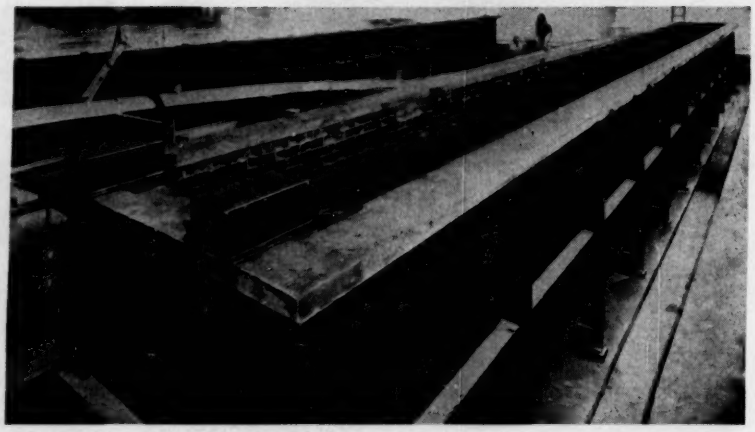
Mr. Swensen is a graduate of Michigan State University. He joined National Carbon Company in 1957.

Carbon Saddle Packing withstands abrupt temperature changes without spalling

Developed jointly by National Carbon Company and The United States Stoneware Company, carbon "INTALOX" saddle packing has a broad range of chemical applications. These saddles are recommended for hot alkalis, mixtures of hydrofluoric and sulphuric acids, hydrofluoric acid, and phosphoric acid—uses where chemical-resistant ceramics would be unsuitable. The unique carbon shape assures maximum contact surface between liquid and gas or between liquid and liquid. For data, write The United States Stoneware Company, 60 East 42nd Street, New York 17, N. Y.

"INTALOX" is a registered trade-mark of The United States Stoneware Company

"NATIONAL" CARBON BRICK LININGS PROVIDE LONG SERVICE LIFE IN TOUGH CORROSION APPLICATIONS



Carbon brick combines unsurpassed resistance to corrosion, abrasion, and thermal shock, with dimensional stability. It is the ideal lining material for tanks, reactors, drain troughs and sumps handling difficult corrosive media.

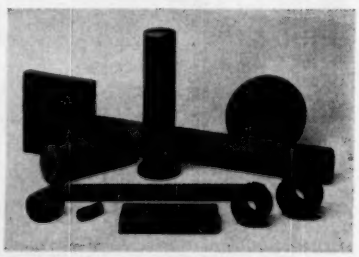
Carbon brick are giving remarkably long service life in sulfate pulp digestors, nitric-hydrofluoric acid pickling tanks, wet process phosphoric acid digestor tanks, organic-sulphuric acid alkylation stripping towers and phosphoric acid concentrators.

The 9" x 4½" x 2½" series is stocked in 11 different shapes. In addition, circle brick 4½" wide x 2½" thick are made to order. For details, request **Catalog Section S-6215.**

"NATIONAL" POROUS CARBON Solves Corrosion Problem in Caustic and HF Filtering

Because of its chemical resistance to sodium hydroxide, hydrofluoric acid, and phosphoric acid, porous carbon is widely used for tubes and plates in filters handling these corrosives.

This versatile material is available in a wide variety of rod, plate, and block sizes. It can easily be machined and fabricated into tube, plate, and tear-drop diffusing and filtering elements.

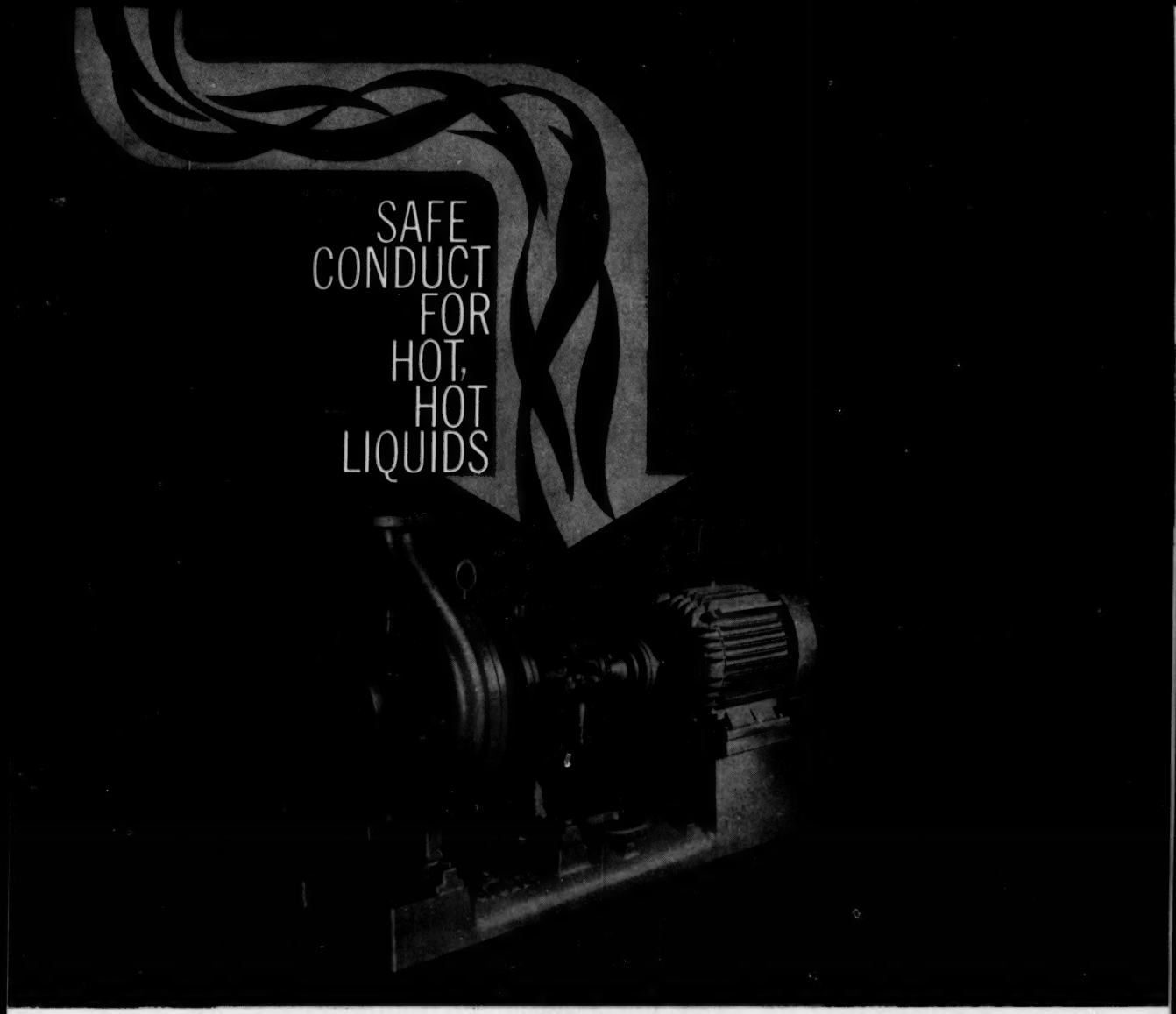


In recent years, porous carbon has also been used as insulation for high-temperature furnaces and reactors, where resistance to corrosion and dimensional stability at high temperatures are essential.

"National", "Union Carbide", "N" and Shield Device and "Karbate" are registered trade-marks for products of

NATIONAL CARBON COMPANY

UNION CARBIDE



Model 3195 centrifugal pump

WHY THIS DUCTILE IRON PUMP HITS 500°F...WITHOUT RISK...WITH LESS COST

Now you can pump liquids as hot as 500° F, low-specific-gravity hydrocarbons and other tough services at working pressures to 275 PSIG without the extra cost of carbon steel.

Ductile Iron resists stress, impact and high pressure as much as carbon steel does—because it has properties similar to carbon steel's.

	Tensile Strength	Yield Strength	Elon-gation	Notes
Cast Iron A48-56	30,000 PSI	0	0	
Goulds Ductile Iron (ASTM A395-56T)	60,000 to 70,000 PSI	45,000 to 50,000 PSI	15-25%	As heat treated to full ferritized anneal
Carbon Steel ASTM A-216-59T-WCB	70,000 PSI	36,000 PSI	22%	

3 Tests Prove Your Pump's Toughness. Each heat of ductile iron goes through three rigorous tests—physical, chemical and microscopic.

We break and twist test bars to make sure tensile strength and elongation conform to ASTM-A395-56T specs. We run a chemical analysis to assure the right base chemistry. Microscopic analysis tests for spheroid structure of graphite and completeness of ferritization.

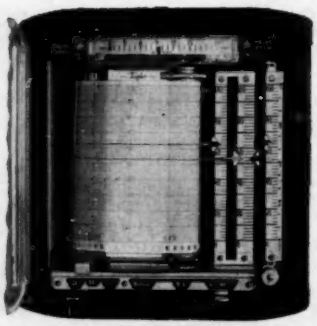
You can get information covering each heat and all castings poured from it. Or we can make tests to your specs.

There's a big story on the Goulds Model 3195, available "off the shelf" in Ductile Iron. Ductile Iron compares to carbon steel in ductility, impact resistance and resistance to thermal shock. Costs less. Both pumping units and pump parts are highly interchangeable. It's available in Ductile-Ni-Resist when corrosion is a factor. Bulletin 725.1 can fill you in with all the details—dimensional interchangeability, bearing frame selection chart, pressure-temperature chart and other helpful information.

Just write Goulds Pumps, Inc., Dept. CE-51, Seneca Falls, New York.

GOULDS PUMPS

ANOTHER Money Saving Feature OF *Taylor Instruments*



SINGLE-CASE CASCADE

A complete Cascade System in one recorder case—in half the normal panel board area, thus conserving control room space—means substantial savings. You need only one case, one chart drive, one panel cut-out.

The single case cascade idea was pioneered by Taylor in the TRANSCOPE* Recorder. Here are some of its features:

All switches in one case. The operator performs all start-up and shut-down operations in one recorder. There are no external switches or relays—the cascade set-point is always in view.

All functions in one case. Master and secondary variables are continuously recorded. Controller outputs, as well as set points, are continuously indicated . . . and with more indications than with any other instruments.

Unique "Petroleum Switching". True cascade control from secondary; or control from master only, direct to the valve without comparing gages.

Front-of-panel control settings permit faster, easier adjustments—the operator can watch results because record is continuous.

Stays on automatic control while the recorder is removed. No process interruption for instrument service or adjustments.

* * *

Single case cascade is another example of Taylor engineering ingenuity that saves you money . . . gives you better process control. See your Taylor Field Engineer, or write for **Bulletin 98286.** *Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.*

*Reg. U.S. Pat. Off.

Taylor Instruments
MEAN ACCURACY FIRST

clean plants, clear profits

with Dracco Multi-Bag Filters

Freedom from dust in your plant can mean:

- **lower plant maintenance and cleaning costs**
- **less abrasive wear on machinery**
- **no raw material waste**
- **better working conditions**
- **improved manpower and machine efficiency**
- **no air pollution**
- **guaranteed product purity**

High-efficiency cloth filtration with Multi-Bag Filters can help you clear the way for profits in any or all of these areas. Wide range of standard sizes permits engineering to meet almost any dry collection requirement. Units can be installed in or out of the plant. Operation may be intermittent or continuous, depending on dust loads and degree of automation desired. Long-life filter bags are available in any type cloth, natural or synthetic.

Freedom from maintenance is another benefit that helps you clear extra profits. Simplified, rugged, design with few moving parts keeps Dracco maintenance costs lowest in the industry, year after year.

For full information on Multi-Bag Filters, and other units in Dracco's complete line of dry collection equipment, write: Dracco Division of Fuller Company, Harvard Avenue and East 116th Street, Cleveland 5, Ohio.

DRACCO *airstream* conveyors dust control equipment

Typical Multi-Bag Filter system at large eastern processing plant shows how standard units can be grouped together to provide unlimited capacities.

NEW CALSILITE-HI® HANDLES SOAKING 1800°F

Light, strong and economical, new Calsilite-Hi is ideal for both insulation and fireproofing where temperatures run over 1250°F up to 1800°F. For lower temperatures than these, Ruberoid's Regular Calsilite® insulation is recommended.

Both Calsilite and new Calsilite-Hi are molded calcium silicate insulation. They're light and easy to install. They cut and mitre quickly, smoothly. They're gentle on hands. They stay strong when wet, won't soften or fall off, return to original thermal efficiency when dry. They resist most industrial chemicals and alkalies. Available in half sectional, three segmental and block form.

For additional information, specifications, and free samples of new Calsilite-Hi or regular Calsilite insulation, mail coupon now.

RUBEROID

Industrial Products Division CE-5-15
The RUBEROID Company
500 Fifth Avenue
New York 36, N. Y.

☐ Please send technical bulletin with specifications
☐ Please send sample of Calsilite-Hi
☐ Please send sample of regular Calsilite

Name_____

Title_____

Company_____

Address_____

City_____ Zone___ State_____

Long-lasting Du Pont Armalon® felt resists harsh chemicals... cuts gasket replacement costs ...reduces downtime

When the job for gaskets calls for exposure to harsh chemicals and temperatures ranging from −100° to +600°F., you need a material that can take punishment in its stride. Du Pont's Armalon* TFE fluorocarbon resin-impregnated felt gives gaskets extended life under extreme operating conditions.

It resists attack by strong acids . . . conforms to uneven flanges . . . provides secure sealing at minimum pressures . . . has high anti-stick properties and low coefficient of friction.

Gaskets of "Armalon" last up to 700% longer than those of ordinary materials . . . cut replacement costs. They resist 99.3% sulfuric acid at 200° C. and often remain in service for a year and a half . . . reduce downtime. Stainless-steel pipes with gaskets of "Armalon" have carried HNO_3 fumes at 170°C. with 97 psi for 7 months with no default in operation.

There are scores of examples showing how "Armalon" proves its performance record under the most exacting conditions. A booklet describing many of these will be sent on request. Mail coupon today.

*"Armalon" is Du Pont's registered trademark for its TFE fluorocarbon resin-impregnated felts.

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DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Dept. CE-14, Wilmington 98, Delaware

Please send me free copy of "Armalon" booklet describing gasketing under extreme condiitons.

Name_____ Position_____

Company_____

Address_____

City_____ Zone_____ State_____

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

LET'S KEEP

Business Help For Our Colleges Going Full Speed Ahead

"Should our company fold up its program of financial help for higher education now that the Kennedy Administration plans to have the federal government provide this kind of help in a big way?" It is clear why, in the light of campaign promises and plans announced since, this question is being raised in many business firms at this juncture.

What seems far clearer, however, is the right answer to the question. It is a resounding NO! **This is no time for the business community to ease up in what have been its notably successful efforts to help our colleges and universities get out of the deep financial hole in which they are operating. On the contrary, this is the time to put more steam than ever behind the drive of business to increase its financial help for higher education.**

Massive Help Needed

It is easy to understand why any individual businessman or firm might have a rather despairing feeling about the prospect of competing with the federal government, with its almost all-embracing tax arm, in providing financial support for higher education or almost anything else for that matter. But this is not a case of competition. It is a case where our colleges and universities must have massive help all along the line if they are to be put squarely back on their feet financially—a goal of crucial and perhaps decisive national importance. **The business community will continue to have both the opportunity and the obligation to keep on increasing its help for higher education as rapidly as possible.**

To underline this proposition take a look at the chart at the top of the next page. It shows how far the salaries of college and university faculty members continue to lag behind those of other occupational groups in the U.S.A. There has been some relative improvement in the average of faculty salaries in recent years. And the salary improvement in some fields, such as those of science and mathematics, has been very pronounced. But the chart makes clear how badly the average salary of college and university faculty members still lags.

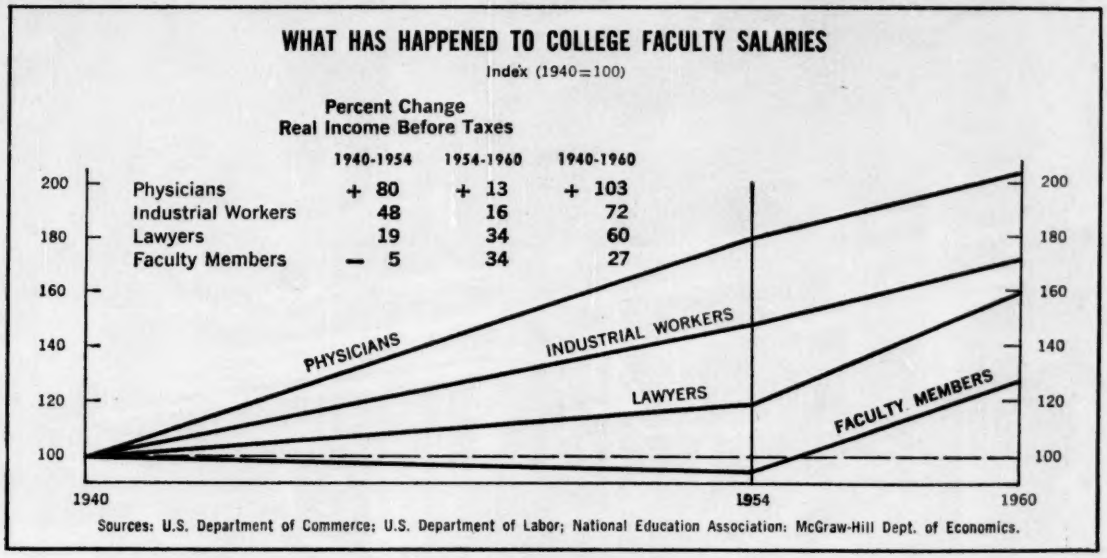
No Federal Funds For Salaries

The plans for increased financial aid for higher education, proposed by President Kennedy, do not contemplate increased expenditure for faculty salaries. This, we believe, is wise whether or not you feel, as many do, that resort to this kind of federal financing would inevitably carry with it federal controls that would ultimately undermine academic independence. The fight over federal appropriations for faculty salaries would be so long and bitter that it would be destructive to the aid program as a whole.

However, what the federal government will not be doing to remedy the deplorable condition of faculty salaries, as reported by the chart, is one indication of the tremendous scope that remains for crucially important help for higher education from business. Manifold other indications are available.

Disaster Escape Route

One of these indications is provided by the careful calculation that the annual income of our colleges and universities must be increased by about $4½ billion (from about $4½ billion to about $9 billion) over the next eight years if the tremendous wave of students



now gathering to descend on these institutions is not to wind up in both a financial and an educational disaster. This wave promises to add more than 2.5 million, or 75%, to college enrollments by 1970.

Thus far, the program for financial help for higher education by business, spearheaded by the Council for Financial Aid to Education, has been a remarkable success in all dimensions. The dollars contributed have increased rapidly—from about $100 million five years ago to about $150 million this year. Contributions of $500 million a year by 1970 are a clear possibility.

One of the inspiring developments increasing this possibility stems out of Cleveland, Ohio. There through their chief executives, an imposing group of business firms have established one per cent of their profits before taxes as their minimum goal for contributions to higher education, to be reached within three years. General acceptance of this goal by business would go most of the way toward getting our colleges and universities firmly on their feet financially.

Mutual Respect Increased

The mutual esteem of the academic community and the business community, an element of enormous importance to a free society, has been increased by the manner in which the program of financial aid has been carried out. In making its contribution, there has been no attempt whatsoever on the part of business to encroach upon the academic freedom of the institutions financially benefited. And the program of financial aid has greatly increased the knowledge, understanding and respect which the colleges and universities and business have for each other.

The Kennedy Administration's program to enlarge federal financial support of higher education is certain to arouse strenuous controversy. As proposed by its Task Force, it avoids some of the most controverial areas of principle. However, the very magnitude of the proposed extension of the federal government's already vast program of financing higher education involves fighting issues.

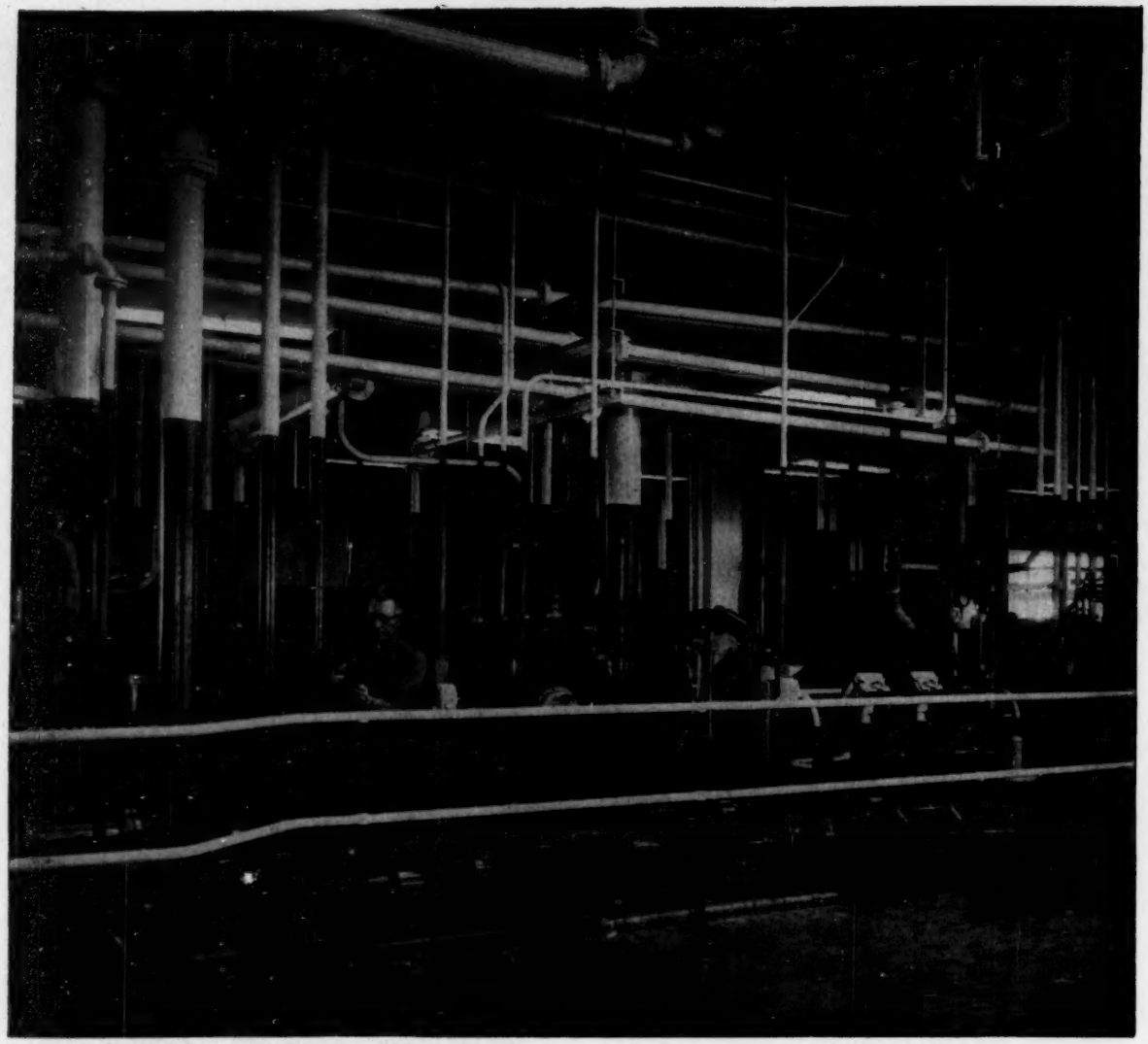
But if the enlargement of federal aid were to be deeply discouraging to the continued expansion of private aid for higher education, it would be a national misfortune of major proportions. There is no good reason why it should be. On the contrary, there is compelling reason for the business community to continue giving higher education all the financial help it possibly can, thus speeding onward a program that has been and continues to be a major constructive force for our colleges and universities, for business and for the nation.

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY



Toms River Chemical Corporation, Toms River, N.J.

SARAN LINED PIPE—no failure after 10 years carrying hot acid loads

Thousands of feet of pipe carry a constant flow of corrosive acids, wet chlorine, sodium hydroxide . . . at temperatures ranging as high as 185° F. . . . where downtime can't be tolerated. Here in the dyestuffs plant of Toms River Chemical Corporation, Toms River, N.J., Saran Lined Pipe delivers its reactive loads year-in, year-out, and needs no time out for repairs.

"Even after 10 years, Saran Lined Pipe needs no replacement or repair," say company officials. "The only maintenance has been cleaning and exterior painting, with occasional servicing of the saran lined valves. For our plant conditions, this is the best, most economical carrier for most of the acids and chemicals we use—HCl, H_2SO_4, SO_2, Cl_2, NaOH, and others.

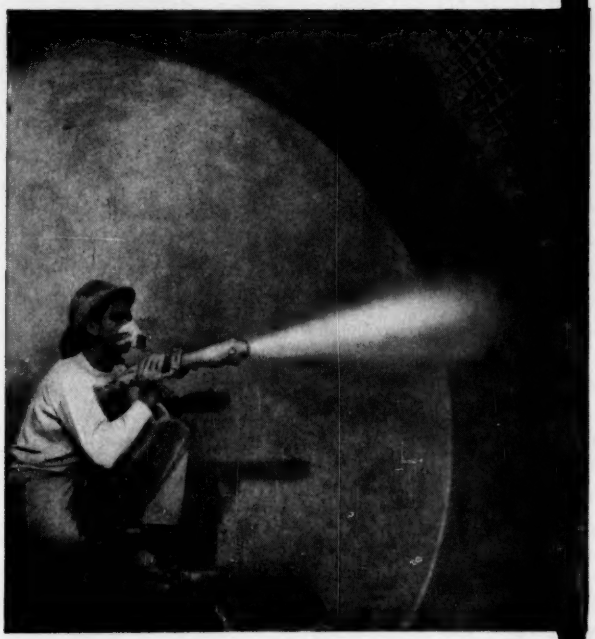
"Unlike other kinds of piping, we can easily cut and assemble Saran Lined Pipe in the field. When errors in measurement occur, they cost far less to correct with Saran Lined Pipe than with other kinds."

For carrying even the most corrosive of chemicals, consider Saran Lined Pipe. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be easily cut, modified and fitted in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1564AK4-15.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan

B&W KAOCRETE-B ...unexcelled for gunning in overhead applications with minimum rebound loss

B&W Kaocrete-B being gunned inside fixed bed desulfurizer vessel.



B&W Kaocrete-B, a specially developed refractory castable is excellent for gunning in vertical or overhanging applications with low rebound loss.

Kaocrete-B is suitable for temperatures encountered in most refining and petrochemical applications. It is extremely easy to apply because it has sufficient plasticity to adhere readily to mesh and walls. Kaocrete-B's low density permits a minimum amount of material to be used, thereby lowering the refractory weight and reducing material cost. Because of its relatively low iron content, B&W Kaocrete-B can be used in most process atmosphere applications.

B&W makes a line of specialized refractory castables which is widely used in the petroleum, petrochemical and chemical industries. Bulletin R-35B contains complete information on B&W Refractory Castables. Send for your copy to: The Babcock & Wilcox Co., Refractories Division, 161 East 42nd Street, New York 17, N. Y.

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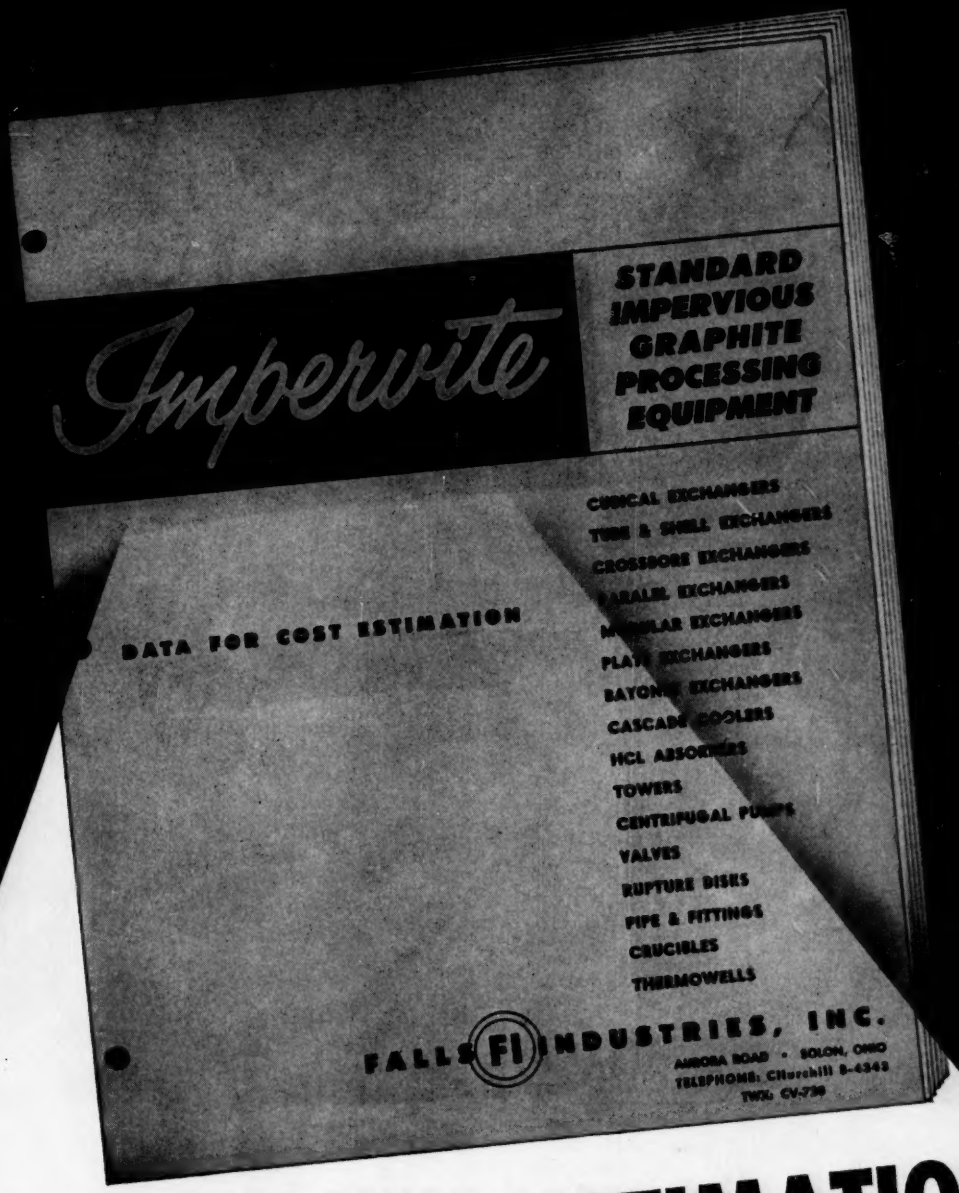
B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.



DATA FOR COST ESTIMATION

Falls Industries provides this 32-page report to keep busy processing people up-to-date on the latest designs and costs of impervious graphite processing equipment. Sixteen different types of equipment are covered from Hydrochloric Acid Absorbers and Cross-Bore Heat Exchangers to Rupture Disks and Thermowells. Information supplied includes standard sizes, dimensions and costs.

Because Falls Industries is so active in developing new and improved impervious graphite processing equipment, this cost and standards report is periodically revised. This present report is the third revision since this service was inaugurated. It is available on request to Engineering Department . . .

FALLS INDUSTRIES, Inc.

Solon, Ohio • Phone: CHurchill 8-4343

Inadequate fire protection. Result: a staggering fire loss at this refinery.

This fire need never have spread!

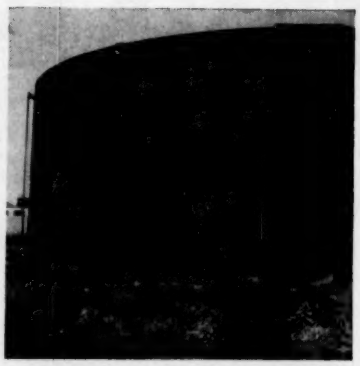
This tank fire did tremendous damage. 30 hours after it started, it was still crumpling storage tanks, buckling railroad cars, twisting track.

Grinnell ProtectoFoam Systems could have saved many of these tanks

When fire breaks out, a Grinnell ProtectoFoam System is ready to go into action. It quickly spreads a uniform blanket of fire-choking foam that covers and extinguishes the blaze. Surrounding tanks are saved.

Grinnell offers you fire protection systems for petroleum products, chemicals, alcohols, solvents, paints, liquefied gas. You benefit from 90 years of fire protection experience when Grinnell designs and installs your systems.

Free 16mm. Sound-Color Film. Grinnell's 35-minute film — "Fire Protection Through Research" — demonstrates all types of special fire hazards, and how to guard against them. To borrow this film — without charge — write: Grinnell Company, Providence 1, Rhode Island.



Grinnell ProtectoFoam protection. This bulk oil storage tank is guarded against destruction by fire.

GRINNELL

FIRE PROTECTION SYSTEMS SINCE 1870

CRITICAL PIPING FOR THE NUCLEAR AGE

A HOT TEST LOOP OF 10″ INCONEL

PIPED BY MIDWEST

for Knolls Atomic Power Laboratory

Through this project . . . an important "first" in atomic power development . . . Midwest proved conclusively that heavywall Inconel piping can be fabricated and erected to meet the most stringent requirements.

Designed for testing materials and components of pressurized water reactors, this loop was fabricated by Midwest's St. Louis plant from Midwest-manufactured Inconel pipe and fittings, 10¾″ O. D. with a wall thickness of 1″. Other Inconel and stainless welding fittings and pipe, Inconel socket welding fittings and Inconel butterfly valves were also manufactured by Midwest.

Erection of the time- and money-saving prefabricated Inconel piping—all auxiliary piping, the complete electrical power and control system and instruments—was handled entirely by Midwest's competent field erection department.

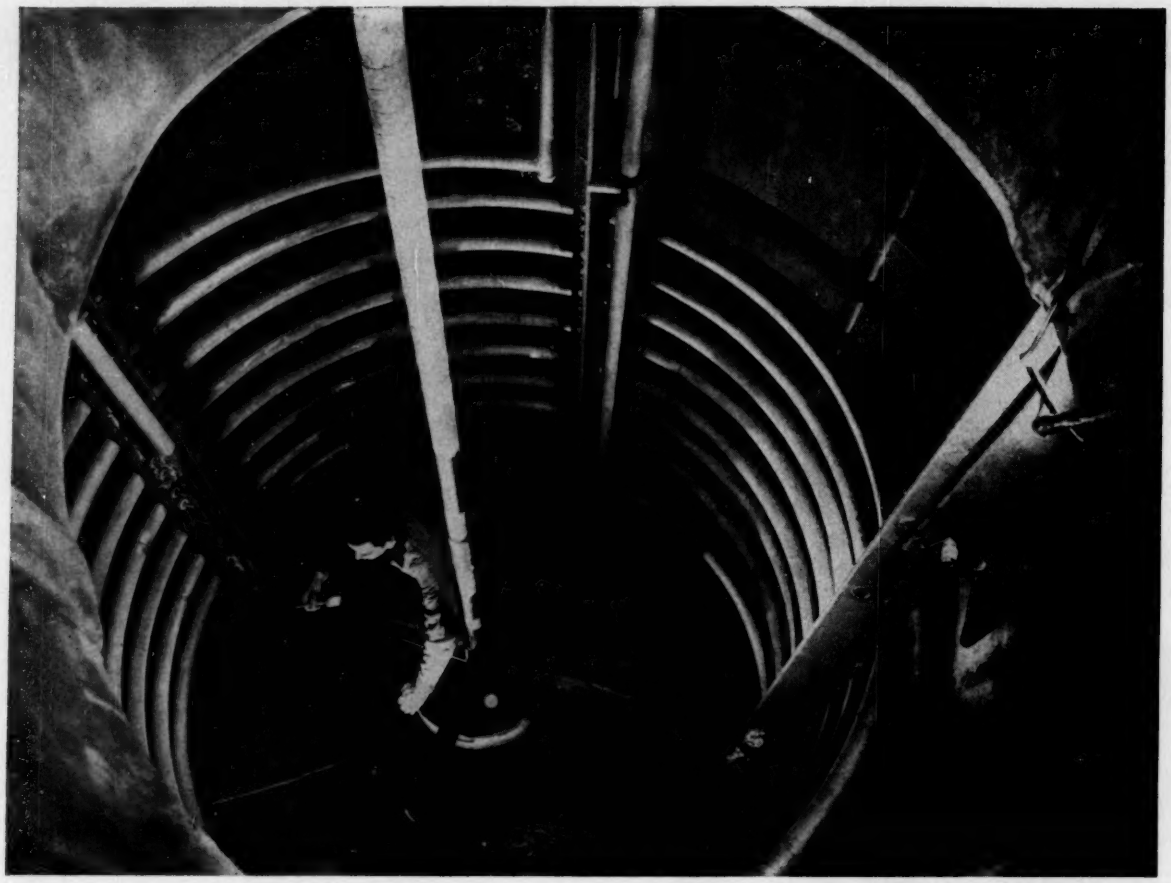
For complete service . . . welding fittings, shop fabricated piping, and erection service . . . CONTACT MIDWEST.

Write for NEW 20-page bulletin—CRITICAL PIPING FOR THE NUCLEAR AGE—describing Midwest's nuclear experience.

MIDWEST

MIDWEST PIPING COMPANY, INC.

1450 South Second Street, St. Louis, Mo.



This titanium coil has eliminated downtime due to corrosion and erosion. Result...

In hypochlorites...

Lifetime Titanium heat exchanger pays for itself with trouble-free performance at Pennsalt

Titanium's ability to withstand hot chlorine environment, its noncontaminating and antifouling characteristics have put a stop to costly trouble before it started in Pennsalt's calcium hypochlorite process.

Two titanium heat exchanger coils are located in the heart of the operation:

Chlorinator. Chilled water pumped through the titanium coil carries off heat evolved when lime slurry is chlorinated. Coil has been completely trouble-free, despite *hot*, wet chlorine environment. No need for repairs. And the chemical buildup on the coil is easily washed off with water.

Pennsalt engineers say that the titanium coil, placed in service in 1959, still shows no sign of corrosion nor erosion. Because of this, the unit has at least paid for itself from reduced downtime.

Crystallizer tank. Still in place after three trouble free years, the titanium coil has far outperformed a vinyl-coated stainless steel coil that lasted for only one year.

Titanium costs are dropping. For example... the latter titanium coil originally cost $6,200. As an experiment, Pennsalt engineers had the unit re-estimated recently. They found that they could purchase a new coil—including an additional $850-worth of spacers—for a total of $4,204!

Lesson to be learned: Selection of the *right* titanium fabricator (TMCA can help you with this) is a sure-fire way of controlling your costs. Also, basic metal prices are improving. In the past three years they have been reduced by 50%.

If you are faced with maintenance problems in equipment operating in wet chlorine... or hypochlorites... or urea ... or inhibited sulfuric acid, contact TMCA. Our chemical experience is at your disposal.

Get the facts:
Performance data... fabrication.
Write Today.

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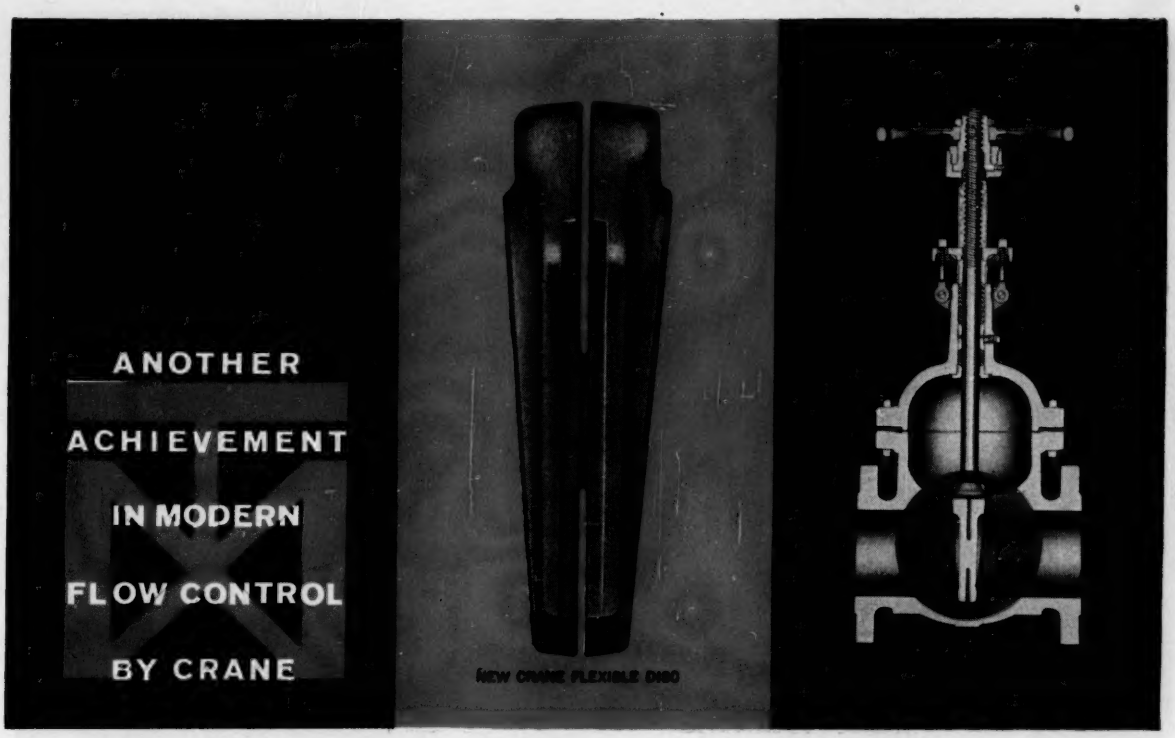

Biggest gate valve advance in 25 years

CRANE FLEX GATES

Instead of being made with a solid disc, new, patented Crane Flex Gates have separate disc faces, connected by the axle-like unit shown in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque... will not stick closed even when closed while hot and allowed to cool.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be serviced—body seat rings replaced or seating faces refinished—quickly, and without painstaking accuracy. Slightly off-taper seats do not affect tightness or operating ease.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes: 12 inch and smaller; 150- and 300-pound pressure classes.

Ask your Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information and products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

CRANE

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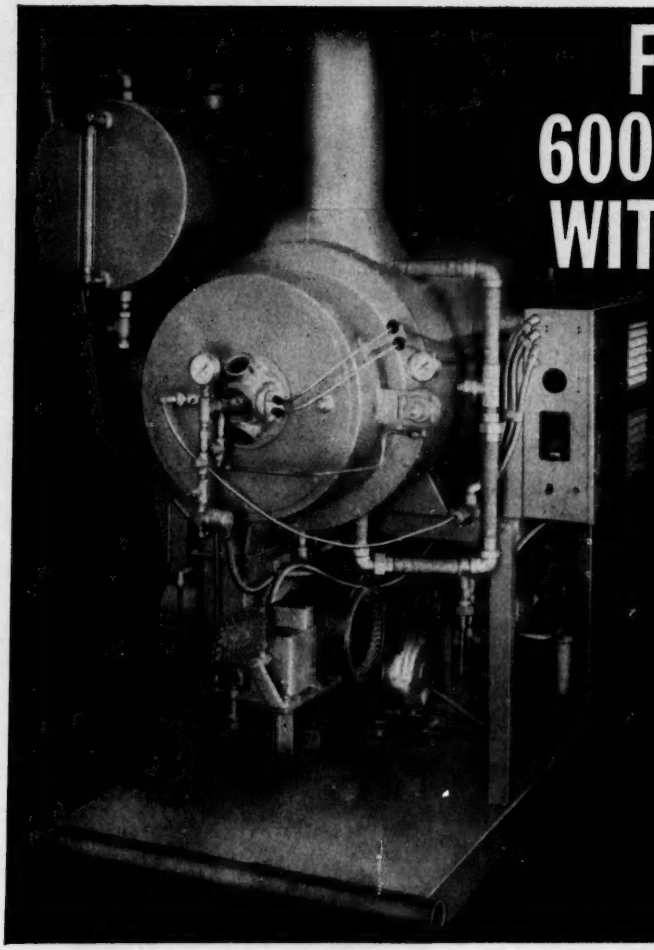
ONE OF A SERIES: THE FINEST FILTER PAPER YOU CAN PUT IN ANY FILTER PRESS IS MADE BY EATON-DIKEMAN

Nobody comes close to matching E-D's experience in industrial filter papers. We're the only company in America engaged exclusively in the manufacture of filter paper for science and industry. We sell it custom-tailored to your process and your press — cut to your size, folded, punched or made into pads . . . with the right combination of characteristics, including wet strength, flow rate, particle retention, weight, and thickness — to help you achieve maximum filtering efficiency and economy. **And when it comes to technical help and service:** at all times, the experience of E-D engineers, technicians and distributors is available to you . . . to help you in the selection of the right E-D paper for your specific application. **Our 24-page catalog on industrial filter papers gives complete details. Just write for Catalog 357.**

THE EATON DIKEMAN COMPANY
Filtertown, Mount Holly Springs, Pennsylvania

Every major filter press manufacturer in America recommends Eaton-Dikeman filter papers.

NEW SYNTHETIC PAPER — Eaton-Dikeman is producing a 100% Dacron paper which is made by the new Du Pont textryl technique. It is very strong, is chemical and heat resistant, and picks up very little moisture. Samples of several weights are available for filtration as well as other uses in the chemical industries. Paper of Orlon and Nylon can also be made by the same technique. Write today.



FOR 600° TEMPERATURES WITHOUT ANY PRESSURE!

VAPOR MODULATIC

HI·R·TEMP

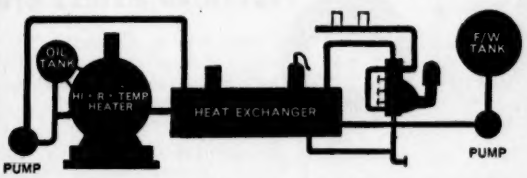
LIQUID PHASE HEATER

This Vapor Modulatic HI·R·TEMP Liquid Phase Heater uses heat transfer aids to provide dependable, automatic, accurately controlled heat transfer to 600° F., without high pressures. Burns natural gas, propane, butane, No. 2 diesel oil, or kerosene. Sizes to 13,000,000 b.t.u.

Check these advantages:

- **ACCURATE TEMPERATURE CONTROL.** Modulating controls automatically maintain pre-determined temperature of heat transfer oil.
- **NO WATER TREATMENT NEEDED.** Eliminates cost of treatment system. No corrosion, scale, freezing problems.
- **POSITIVE OIL FLOW.** Rotary gear pump assures uniform circulation...prevents hot-spots, coking, sludging, oil breakdown.
- **LOW INSTALLATION COST.** Completely unitized, skid-mounted with all piping in place. Factory tested before shipment. Compact, lightweight...install it anywhere.
- **LOW-PRESSURE VESSELS AND FLOW CIRCUITS.** Saves the cost of heavy-duty piping, fittings, valves.
- **COLD OIL SEAL.** Expansion tank is uninsulated and isolated from main flow of hot transfer oil. Protects oil against atmosphere, sludging, deterioration.
- **OPTIMUM SAFETY.** Non-toxic. Built to ASME codes. Flame failure, low oil level, high temperature safety shut-off controls are standard. CO_2 quenching ring optional.
- **LOW OPERATING COST.** Forced-draft combustion, coiled tube design is highly efficient. No high pressures, does not require licensed engineer to operate.

here's how one vapor Hi·R·Temp, with heat exchangers, can supply your needs for processing, heating, hot water, etc.



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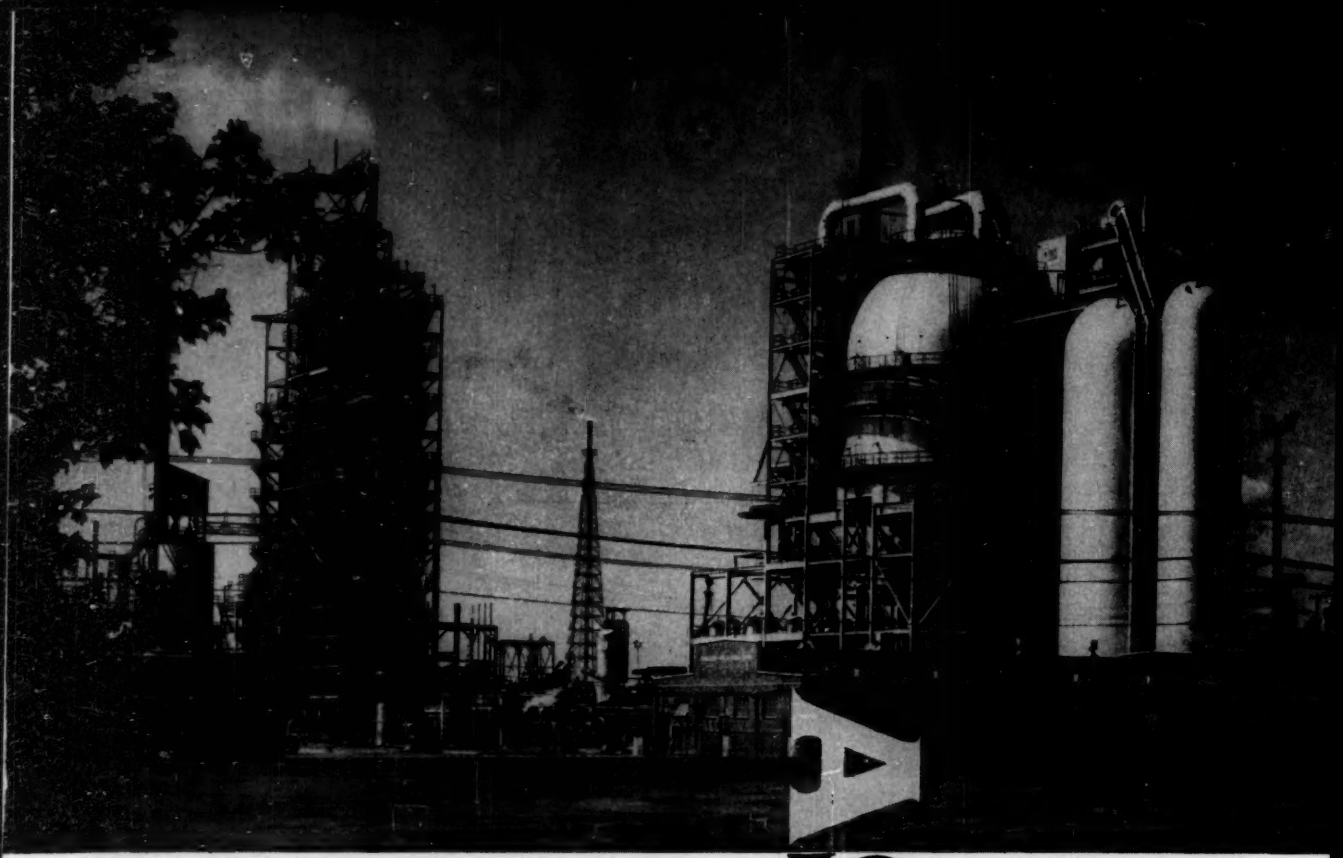

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ECO ENGINEERING NEWS

the big name in small pumps for the process industries

Pumping Solvents and Caustic Soda at Reichhold

At the Ballardvale, Mass., manufacturing unit of the Reichhold Chemical Corp., Eco GEARCHEM Pumps of 316 stainless steel are transferring special solvents directly from shipping drums to weigh tanks and metering caustic soda in the manufacture of liquid epoxy resin.

This plant makes a variety of synthetic resins used principally by the electronics industry, and by manufacturers of primer paints for automobiles.

Engineer Hatton opens valve to permit Eco GEARCHEM Pump to convey solvent from drum to overhead weigh tank. Head is about 15 ft. Solvent is of low viscosity at room temperature. Flow is about 10 gpm.

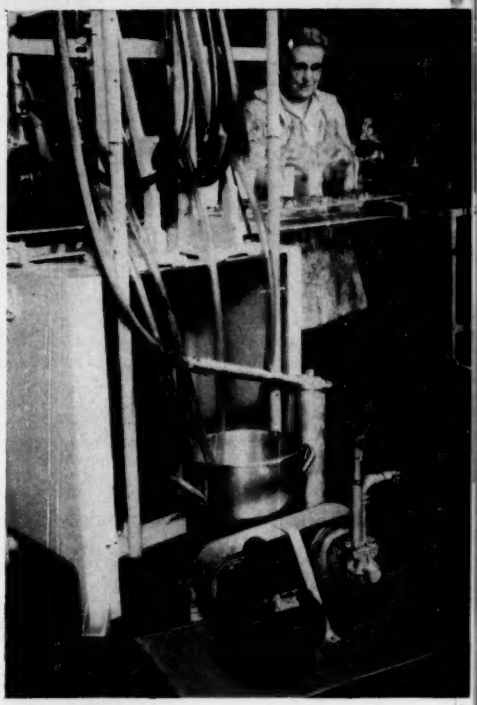
The Eco GEARCHEM Pumps have been in service at Ballardvale for 2 years and operating management estimates that they will have a life expectancy of about 10 years service.

Commenting on the pumps, they termed the GEARCHEM "a good rugged little pump. It's priced low and it stands up."

The broad choice of gear materials was also considered a distinct advantage as it permits selection from such materials as synthetic rubber, carbon, Teflon†, Penton× and Hastelloy* to adapt pumps to specific media and conditions.

†du Pont Trademark *Union Carbide Trademark
×Hercules Powder Co. Trademark

One of the First ALL-CHEM Pumps Still on Job after 9 Years Continuous Service



This Eco stainless steel ALL-CHEM Pump was purchased in 1952 to pump shampoos through a polishing filter to the head tank of a gravity-feed bottle-filling machine. It is still on the job, nine years later.

In addition to other cosmetics, Rilling Dermetics makes shampoos and cold wave solutions highly esteemed by professional hairdressers for more than 20 years.

Today Rilling Dermetics has several ALL-CHEM Pumps transferring oils, alcohols and liquids in process from tanks to kettles to filling machines.

The extreme dependability, freedom from excessive maintenance, and long life, as demonstrated by their original pump, has prompted Rilling Dermetics to standardize on this rotary displacement pump which also offers the added advantages of being self-priming, delivering linear, non-segmented, non-foaming flows ideal for shear sensitive emulsions and easy portability for moving from one pumping need to another in the plant.

Last summer the original, nine-year-old ALL-CHEM Pump was sent into the Eco Factory for overhaul and necessary replacement of internal parts. It was further gratifying to the customer to find that standard, inexpensive, precision "in stock" parts were available to service even this veteran pump.

Pumps Chloroform . . . Stays Awake!

Once thought of only as an anesthetic, chloroform is now a widely used industrial chemical—in the production of antibiotics, as an intermediate for refrigerants and propellants, in the manufacture of dyes and drugs, and as a general solvent.

Because chloroform is one of the more hazardous materials and is a heavy, oily, volatile liquid which has a specific gravity of about 1.5, it presents a pumping problem. Eco GEARCHEM Pumps in Hastelloy C construction and driven by explosion proof air motors, are being selected for their self-priming characteristics and are proving particularly satisfactory in drum and transfer service.

Pumping New Wire Coating Enamels

Good news gets around.

Some time ago a Michigan manufacturer tried out an Eco 316 stainless steel GEARCHEM Pump to pump the newer wire coating enamels which require a corrosion resistant pump because of their chemical composition. Other requirements were resistance to the abrasive effects of the ultra fine contents of dispersed pigments; enamel viscosity is 5 to 600 SSU at approximately 100° F. Pumps must deliver material at 2 to 3 gpm against 30 to 50 psi. On the basis of performance, Eco GEARCHEM Pumps are now becoming standardized for corrosive wire enamel service.

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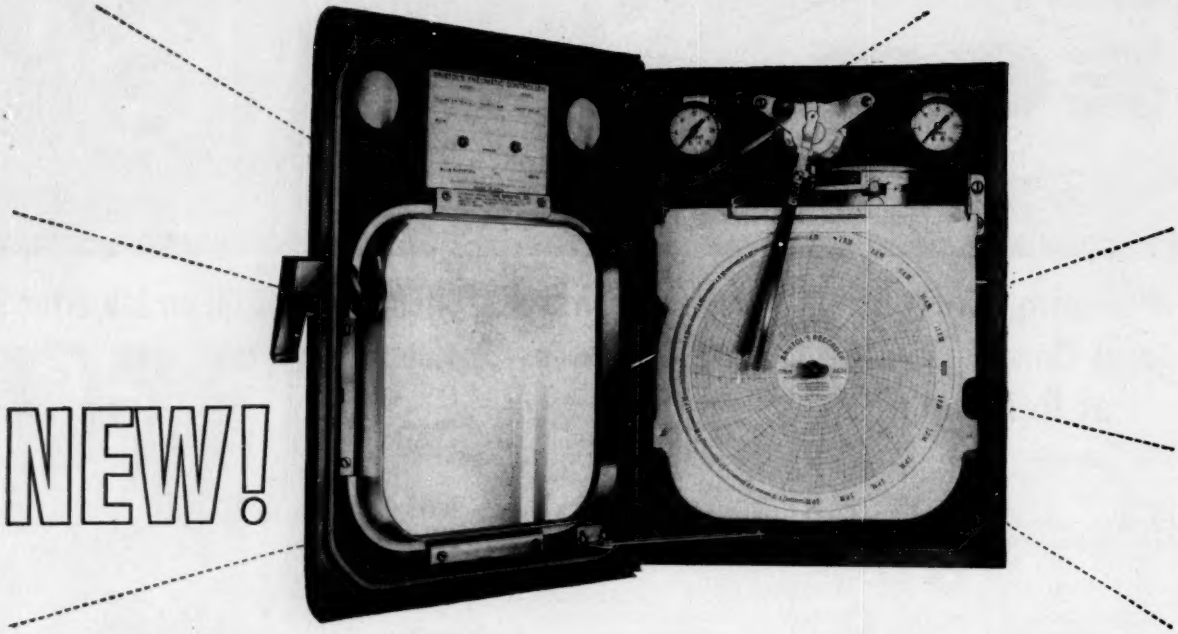

Bristol Series 532 A/D* pneumatic recording controller is outstandingly SIMPLE, RELIABLE, and STABLE

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- **Designed for batch-type and continuous processes**
- **Proportional, proportional-plus-reset, and proportional-plus-derivative control models available**

Top control performance with maximum simplicity plus standard Bristol precision measuring elements—those are the key features of the Bristol Series 532 Recording Controller. The 532 uses the same renowned elements that have earned such a reputation for accuracy and dependability on other Bristol automatic controlling and recording instruments—perfected through wide experience and many years of development.

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Write for complete data on the new, versatile, economical 532 A/D. The Bristol Company, 109 Bristol Road, Waterbury 20, Conn., a Subsidiary of American Chain & Cable Company, Inc. 0.46

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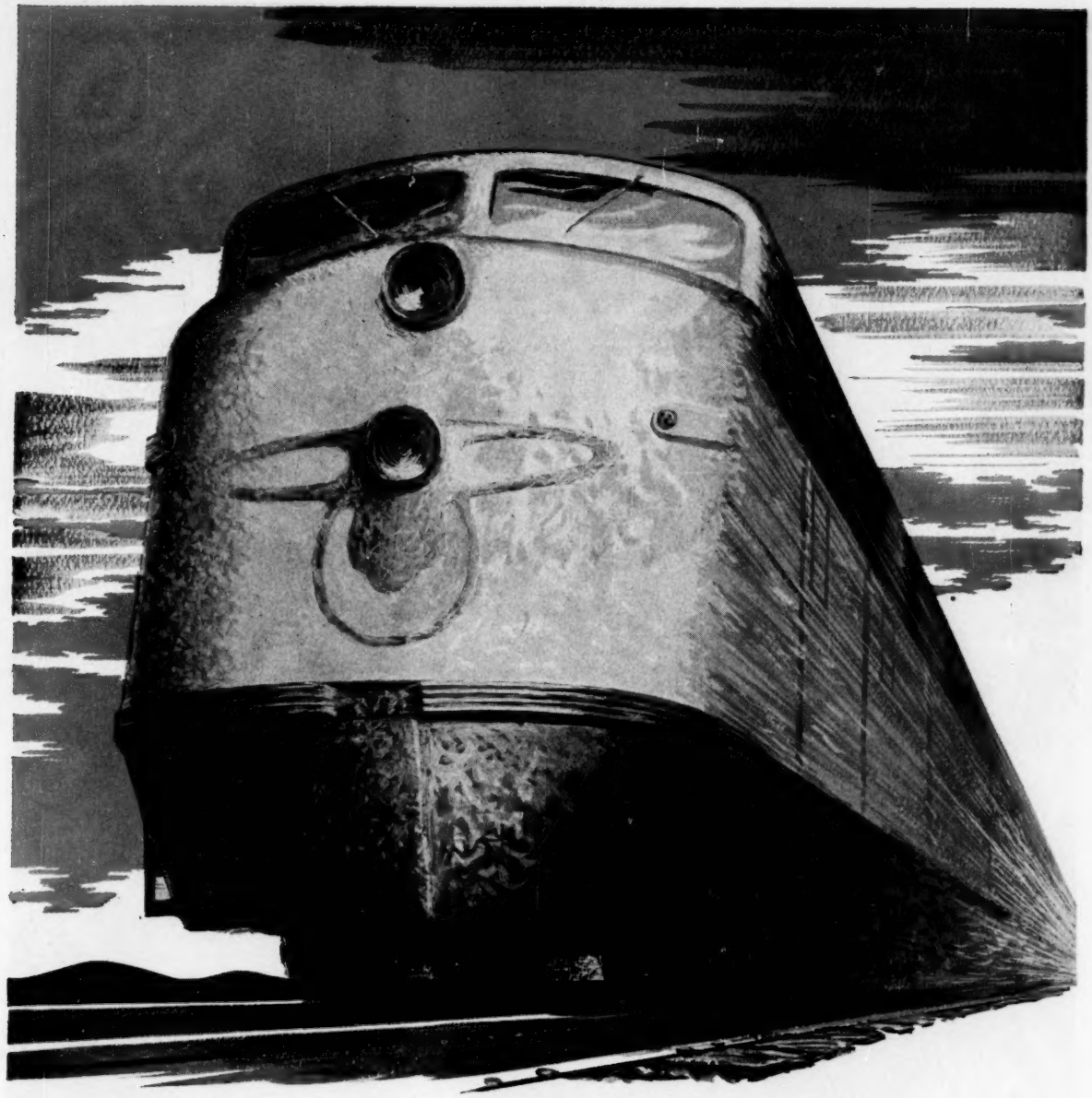

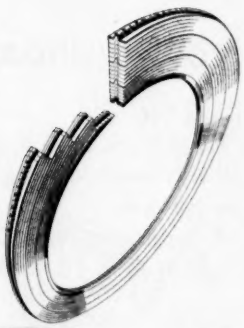

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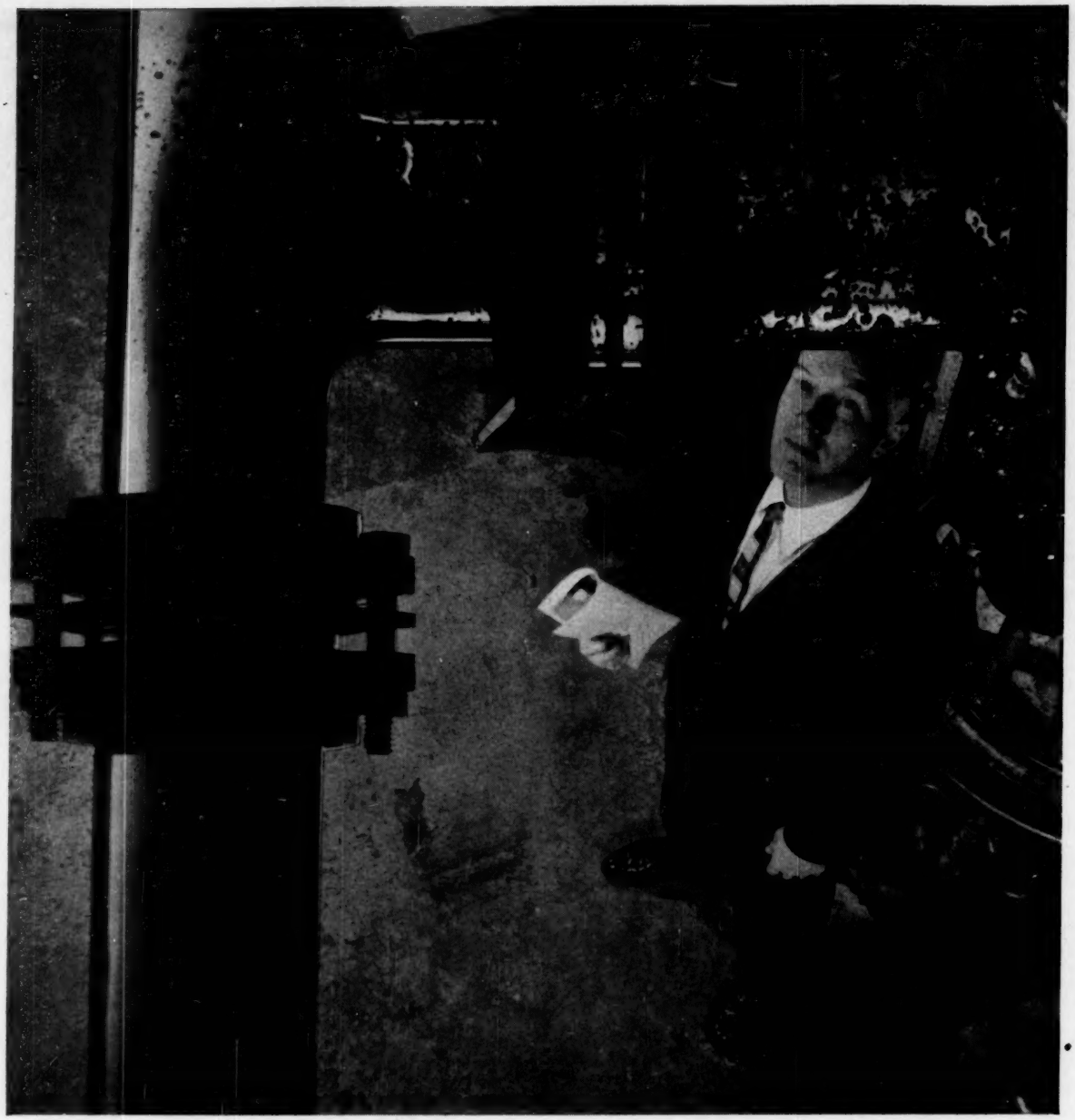

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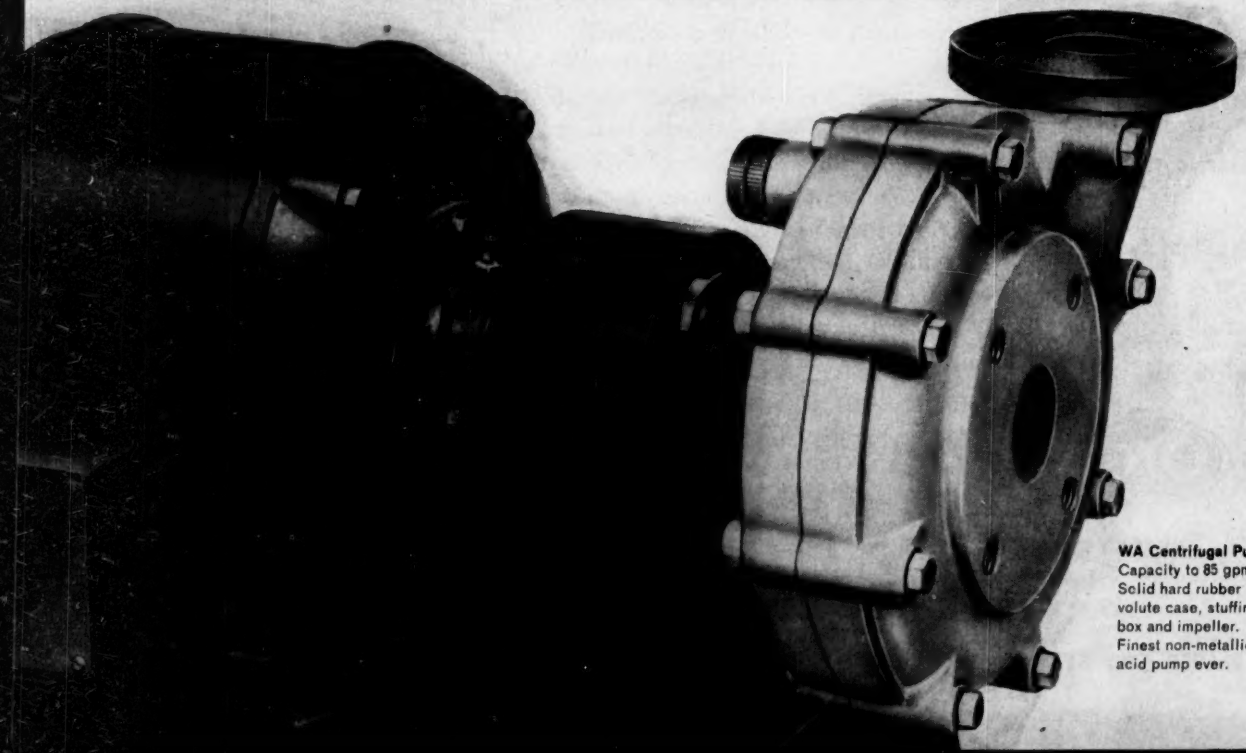
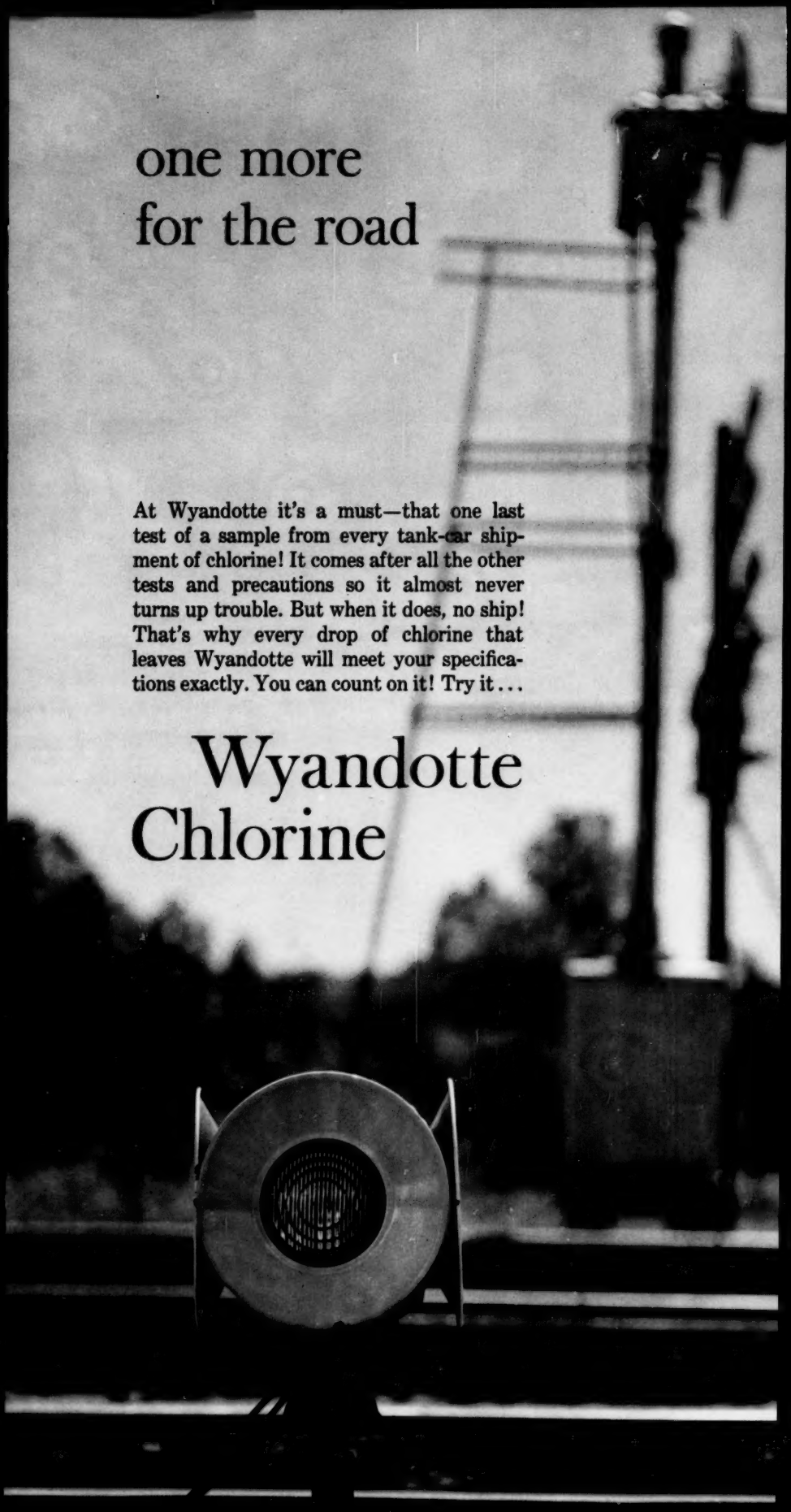
Ace Jabsco Neoprene Impeller Pump: Handles amazing volume. 15 gpm. at 22 ft. head to 5 gpm. at 72 ft. Hard rubber casing, neoprene impeller. Self priming.



WA Centrifugal Pump: Capacity to 85 gpm. Solid hard rubber volute case, stuffing box and impeller. Finest non-metallic acid pump ever.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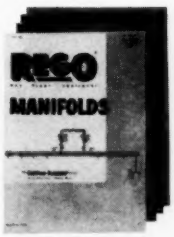

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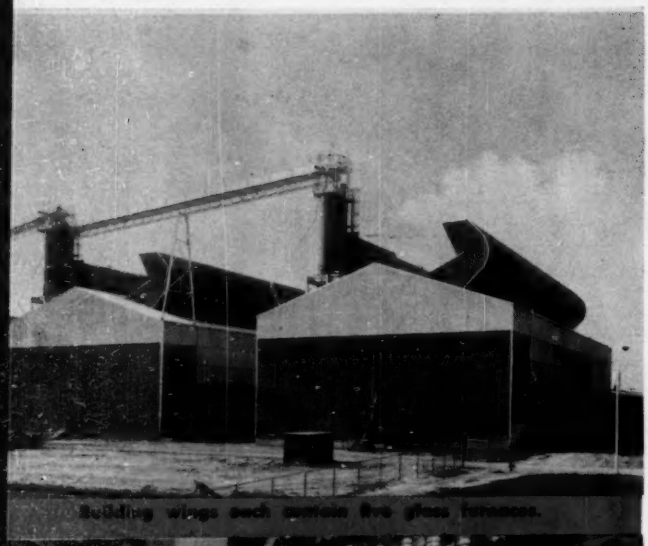
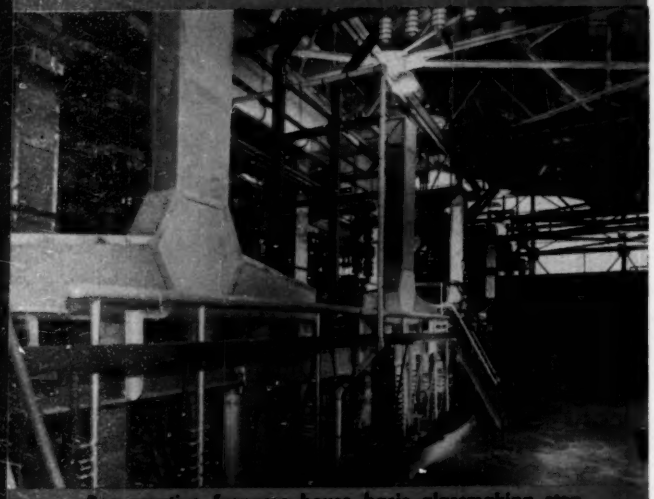
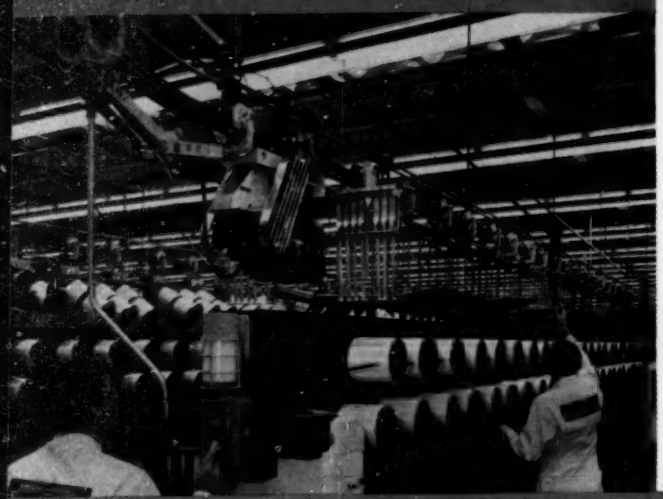
Process Flowsheet



Building wings each contain five glass furnaces.



Recuperative furnaces house basic glassmaking step.

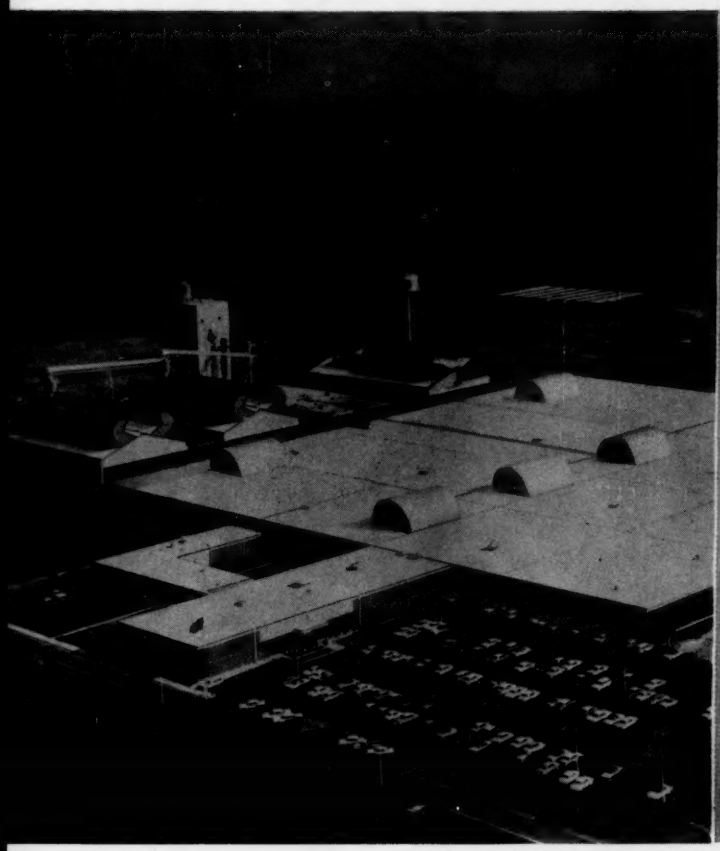


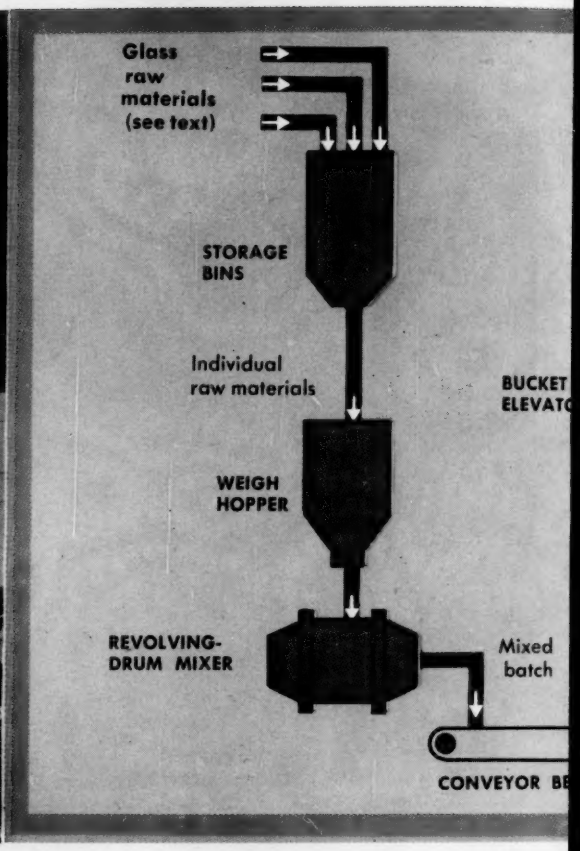
Spinning machines convert strands to finished yarn.

New Plant Features Latest Look In Making Glass Fibers

N. P. CHOPEY, *Assistant Editor*

Unfold flowsheet





Two facts, not unusual in themselves but rarely found in combination, characterize the glass fibers business. It has grown breathtakingly since its infancy in the 1930's; its history has coincided with the life of one principal producer.

The producer, of course, is Owens-Corning Fiberglas Corp., which made glass fibers a commercial reality some 25 yr. ago. Indeed, company is so closely identified with the field that its Fiberglas trade name is often mistaken for the generic term when discussing these versatile fiber materials.

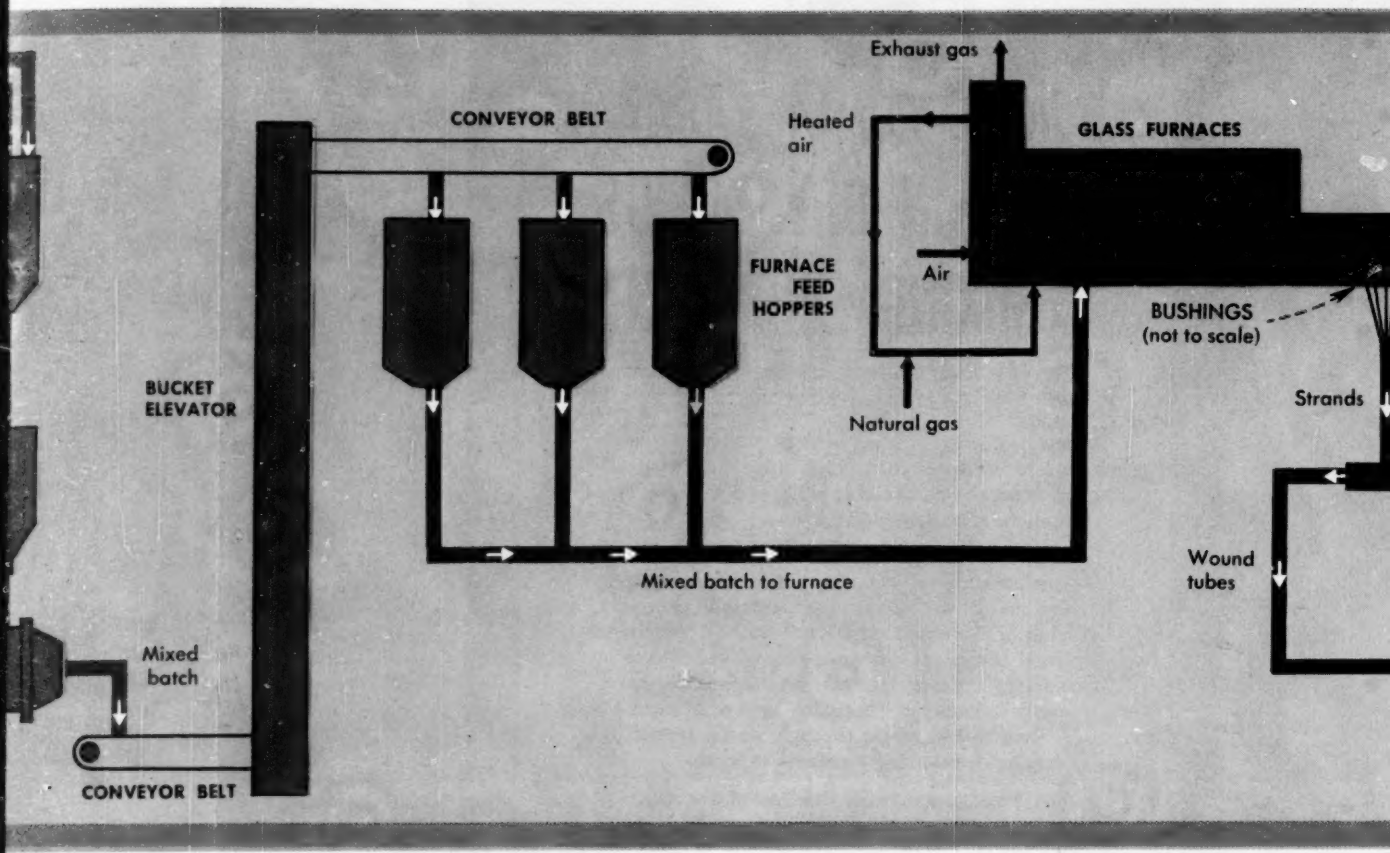
With six producers in the field, Owens-Corning's 1959 sales—$211 million—represented a healthy 72.9% of total. Although 1960's $218-million sales figure didn't meet company expectations, industry experts have it that the glass fibers field will continue to be a prolific one (*Chem. Eng.*, Aug. 8, 1960, p. 72).

Evidence that the company intends to grow with the market is provided by a huge, highly modern plant that was started up last year to make continuous-filament yarn at Aiken, S. C. Capacity depends on the slate of product grades made—heavy fibers are easier to produce than light ones—but a representative figure is over 50 million lb./yr.

The facility produces fibers in about eight basic diameters, which in turn are combined to yield yarns of various plies. Currently, the big market for continuous-filament yarn is for textiles. Principal textile uses are in drapery and decorative fabrics; others include reinforced plastics and electrical insulation.

▶ **Last Word in Processing**—Process modernity of the Aiken plant can be seen by comparing its flowsheet with Owens-Corning technology as described in June 1947 by *Chemical Engineering*.

General sequence for making continuous-filament yarn is easily summarized. Glass raw materials are proportioned and combined, then charged to a furnace. Molten glass passes through orifices and the filaments thus produced combine into strands, which in turn are spun to form product yarn. The specific modernizations that Owens-Corning engineers have woven into this procedure at Aiken show up clearly when process flow through the plant is followed.



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► **Automatic Batching**—Company's basic ingredient slate for continuous-filament fiber is as follows:

Silicon dioxide	**52-56%**
Calcium oxide	**16-25%**
Aluminum oxide	**12-16%**
Boron oxide	**8-13%**
Sodium and potassium oxides	**0- 1%**
Magnesium oxide	**0- 6%**

The low strong-alkali level is typical for glass-fiber formulations, to reduce susceptibility to corrosion. Because of this low content, the glass-forming reaction takes place at a higher temperature than when making, for instance, plate glass.

Hopper cars convey the raw materials from rail unloading to batching facilities. Aiken's batching unit furnishes the first evidence of the plant's modernity—it operates fully automatically, controlled from a central programming board.

A weigh hopper proportions the individual ingredients, discharges them into a revolving-drum mixer. Mixing time is about five minutes. The combined batch is then conveyed to feed hoppers in the furnace area.

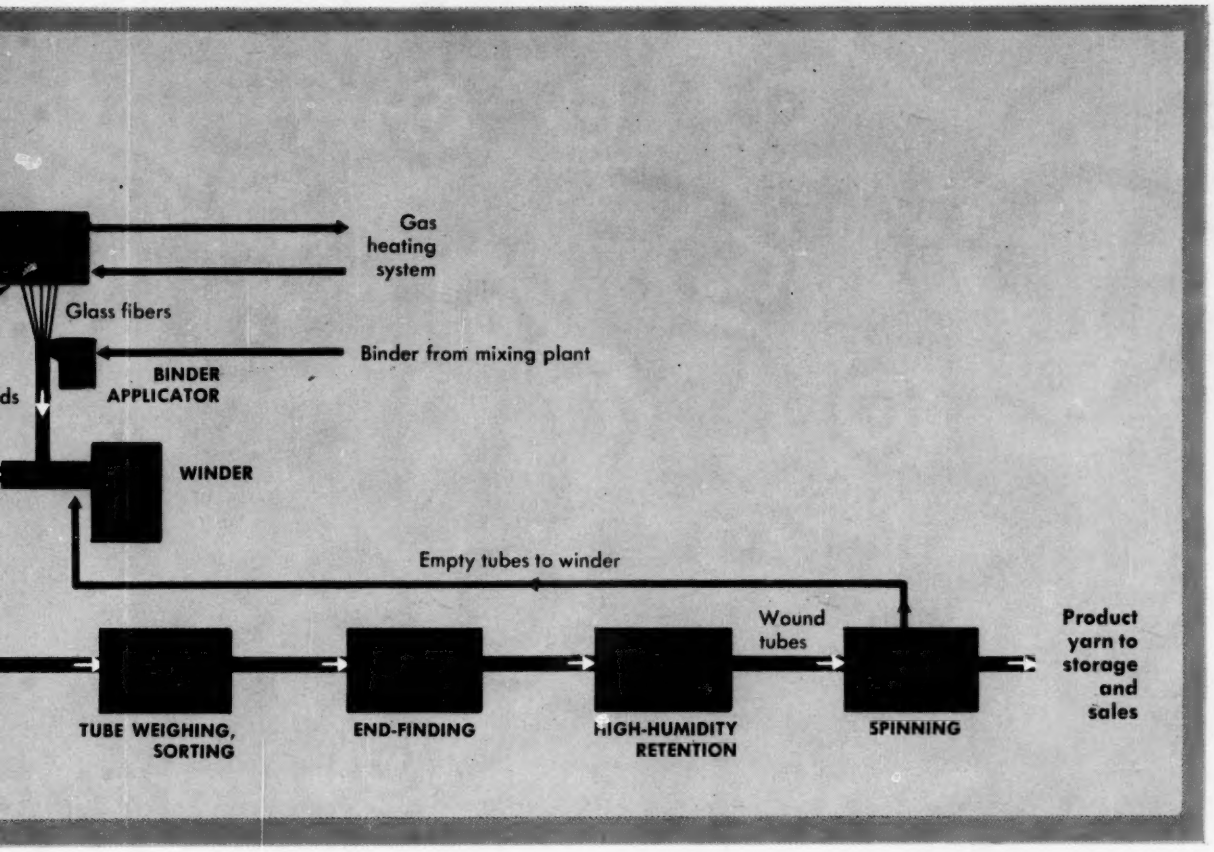
► **Modern Furnace Design**—Aiken's glass furnaces are also worthy of notice. For one thing, they feature a recuperative rather than regenerative system for heat recovery from spent fuel gases.

Regenerative furnaces recover heat by alternately passing exiting hot gas and incoming air across brick checkerwork. In the recuperative system, heat transfer takes place continuously between gas and air in adjacent passages.

Designers of large glass furnaces have generally avoided the latter system in the past, because it can lead to leaking or clogging problems. Owens-Corning, however, likes the more-accurate temperature control inherent in recuperative operation and is using carefully designed recuperative furnaces at Aiken. (Company is phasing into this type of operation at its other plants as well.)

Without disclosing details, firm's engineers also state that the furnaces incorporate what is believed to be the optimum ratio between hearth length and width.

Melting temperature is around 2,800 F. The molten glass produced passes through the refining portions of the furnaces, then on to forehearth



sections where temperature is kept in the 2,300-2,400 F. range. Temperature control is especially important here, so the forehearths are heated by an independent gas system.

Glass filaments are drawn directly from the forehearths, and this procedure constitutes the next feature of the new plant.

▶**No More Marbles**—In earlier continuous-filament operation, glassmakers formed the melter-refiner product into marbles. These were inspected for quality, then remelted in an electric furnace for filament drawing. Owens-Corning feels that its present know-how in glass technology, as built into ingredient batching and furnace design, permits bypassing the marbles step—except in the case of very fine fibers, not produced at Aiken.

Molten glass emerges from the forehearths through orifices in platinum-rhodium bushings. Average filament diameter is about 0.00025 in.; company varies this by changing the bushings.

▶**Binding and Winding**—The filaments are gathered together and treated with a binder material, and a winding machine then collects the resulting strand on a spindle.

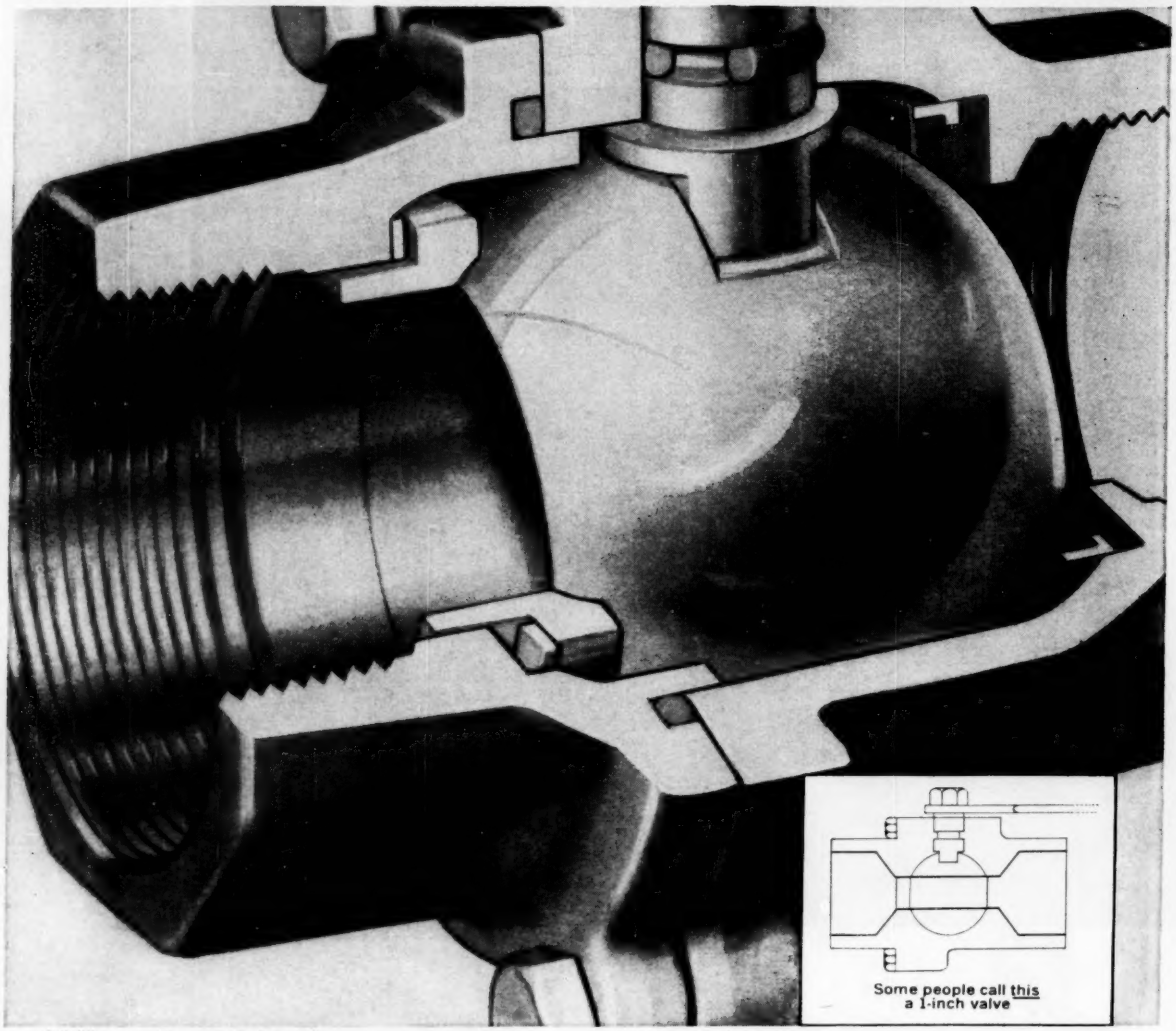
Processing the binder materials is also a modern operation at Aiken, but one that Owens-Corning will not elaborate upon. Company uses various formulations of starch-based substances, produces them in a complex, automated unit.

The winding step has three features that distinguish it from older practice. To achieve precise control of speed (there is an optimum winding speed for each filament diameter), a d.c. drive system that incorporates a motor-frequency generator is used, rather than a conventional a.c. motor. The packages of wound strand are bigger than in the past, and when finished they are automatically taken away from the winder.

▶**Finishing**—Tubes go to a weighing station for inspection, then to a manual operation for finding the ends of the strands. Next, the tubes are stored under conditions of high humidity, to allow the binder to set. Minimum retention time varies with the binder used, can be 1-16 hr.

An efficient monorail system routes the tubes from the storage area to spinning machines, which twist and ply the strands into finished product fiber.

TAKE A CLOSE LOOK AT ROCKWOOD BALL VALVES



When is a 1-inch valve NOT a 1-inch valve?

When the waterway diameter of a ball valve is smaller than the pipe size you can't get perfectly smooth flow. If this difference is large, flow is more turbulent and pressure loss much greater. So it pays to compare waterway sizes before you buy any ball valve. You'll find that Rockwood ball valves have the largest waterway diameters — per given valve size. This means smoother, more economical operation in your line — whether you move liquid, gas or solids.

Rockwood Ball Valves have these other important advantages too.

Ruggedness — durably built for longer service under severe use.

Spring-loaded Ball Seats — compensate for wear, pressure change and temperature effects.

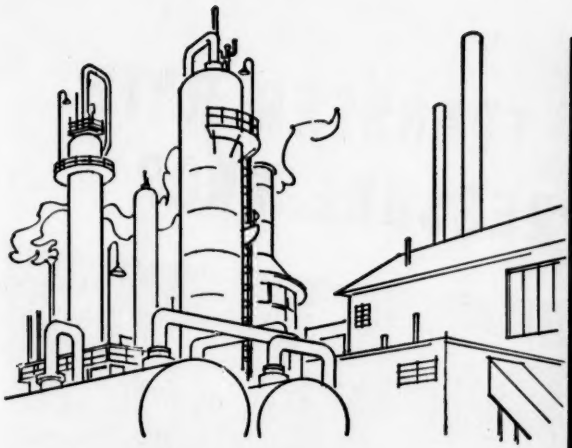
Choice — a wide range of design variations including metal castings of stainless steel, carbon steel or bronze; lever, gear, air, hydraulic or electric operators; standard or top entry types; rubber, Teflon, Kel F or nylon ball seats; flanged, sweat or screw ends — in a full range of pipe sizes from ⅛" to 14".

Reliability — Rockwood ball valves are manufactured by the pioneer in modern ball valve design and are both time- and use-proven in dependable operation and quality of construction.

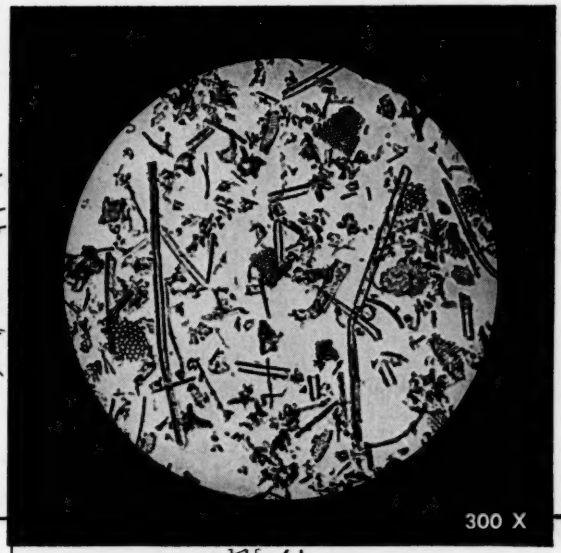
Why not call in a Rockwood man today? He'll give you the complete Rockwood story. Write Rockwood Sprinkler Company, Ball Valve Department, 271 Harlow Street, Worcester 5, Mass. Distributors in all principal industrial areas. Rockwood Sprinkler Company, A Division of The Gamewell Company, A Subsidiary of E. W. Bliss Company.

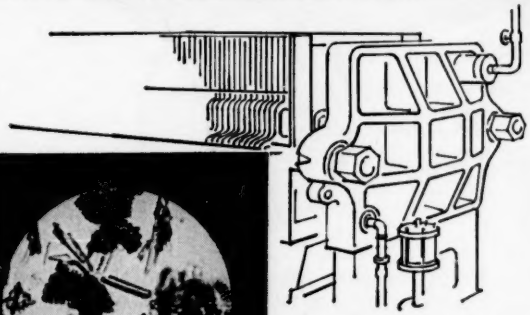
ROCKWOOD

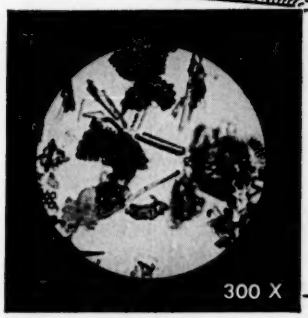
BALL VALVES



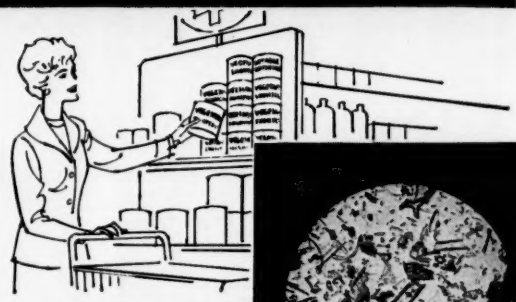
For flow rate plus clarity—Hyflo Super-Cel has the right combination of large and fine particles. Heavily used in chemical processes such as caustic soda production.

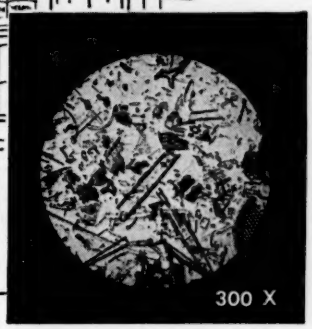






For fast flow rates—Celite 545 has a higher proportion of coarse particles. Frequently used for clarification of resins and other viscous liquids.





For maximum clarity—Filter-Cel has a relatively fine particle size distribution. Used in producing lard, salad oil, other hydrogenated oil products.

In diatomites, Johns-Manville precision processing works for you

Celite has the exact grade for every filtration need from fast flow rate to maximum clarity

Study samples of various filtration grades of Celite* diatomite with the unaided eye. Rub them between your fingers. One grade looks, feels very much like another.

Then compare these grades under the microscope. Each has its own distinctive particle size distribution. Each is precision-milled to fill the most exacting filtration requirements, ranging all the way from maximum flow rate to maximum clarity.

Celite 545, for example, with a higher proportion of large to fine particles, is used to remove large suspended impurities at maximum flow rates. *Hyflo Super-Cel®* has a balanced particle size distribution, combines good liquid clarity and moderate flow rate. But *Filter-Cel®* has a much higher ratio of small particles, is tailored for use where high clarity outweighs flow rate.

Whatever your filtration problem—Johns-Manville can furnish the "right" grade for the job. You have a choice of 9 intermediate grades *plus* many special grades. Each comes from the largest and purest commercially available deposit. Each is processed and graded at the same plant under the same uniform conditions.

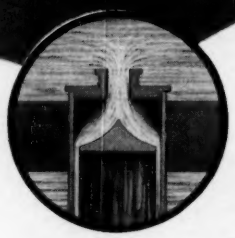
For information on specific filtration or mineral filler problems, talk to your nearby Celite engineer, or write to us. Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products

JOHNS-MANVILLE

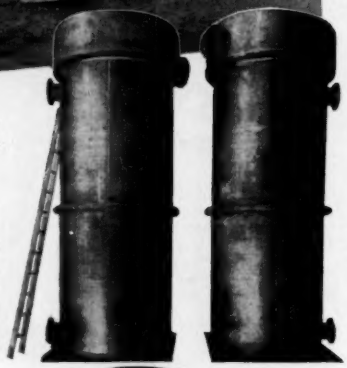
NOW HIGH HEAT TRANSFER RATE with LOW PRESSURE DROP

Another Vogt



*One of the many distributor types developed for various applications.**

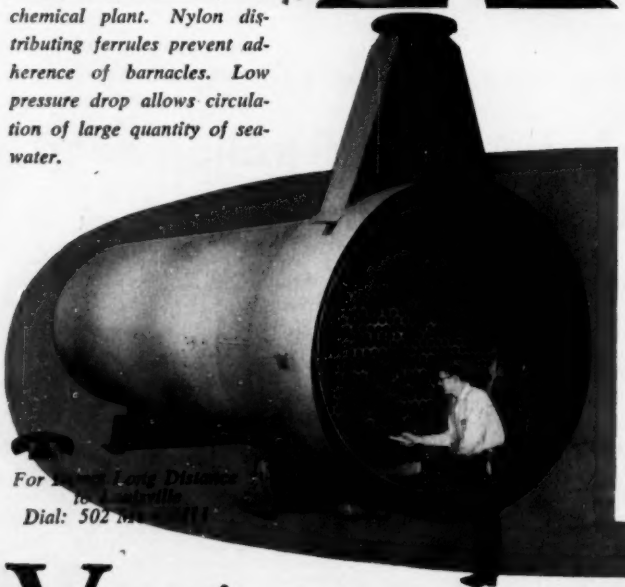
**Covered by Pat Nos. 2,057,597, 2,424,441 and others pending.*



TOP: *Muddy well water is the coolant for these Jacket Water Coolers.*

RIGHT: *Two 56" Dia. x 12'0" high Amine Solution Coolers with expansion joints in shell.*

BOTTOM: *One of a number of seawater cycle units for a chemical plant. Nylon distributing ferrules prevent adherence of barnacles. Low pressure drop allows circulation of large quantity of seawater.*



Special metering distributors control the flow in vertical Vogt film type exchangers of single tube-pass design. The liquid is spread in a uniform film over the inside surface of the tubes. Since the liquid falls by gravity, good velocity is obtained with a small quantity of liquid.

Vogt has developed many types of distributors which are made from a variety of materials to accommodate the fluids circulated through the tubes in specific processing operations.

A unique feature of these exchangers is that the tube side can be cleaned while in operation.

Vogt Film Type Exchangers are used as Coolers, Condensers, Absorbers, Heaters, and Evaporators.

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CE Feature Report

How to Appraise Capital Investments

In this "profit-squeeze" economy, having really good systems for appraising and controlling new capital investments becomes more important than ever for process companies. Here is some practical advice.

JOHN W. HACKNEY
Pan-American Management Ltd.

There are many powerful forces at work today that tend to reduce the take-home pay of chemical process companies, despite rising sales.

One major opportunity for improving profits presents itself when a company is considering new capital investments. Here is where mediocre and poor projects from an investment standpoint can be eliminated promptly, and where good projects should be confidently identified and pushed to early completion.

Admittedly, this is a difficult task, particularly on large, complex jobs. But it seems clear that for the chemical process industries, sustained profits in the future will go to those companies having sound systems for realistic appraisal of their investments.

Basically, control of capital ventures for maximum profit includes these five important elements:

- Estimating the investment required.
- Forecasting profitability.
- Selecting projects of best return, considering risks involved.
- Monitoring costs and progress during construction.
- Reviewing performance for further improvement.

In this report, we will discuss reasons why formal procedures are needed for the control of appropriated funds for capital ventures; when and how requests should be made for funds; how to measure a company's true total investment in a project; how to forecast income and return; profitability and risk measurements; progress, control and performance reports.

When applied in a practical way, with a positive, creative attitude, these procedures can play a major role in improving corporate profits.

Why Justify and Control?

A new project is not started because it's a "good idea." It must be formally requested, justified and controlled.

Almost every large corporation finds it necessary to set up formal procedures for requesting, approving and controlling funds used for purposes outside the usual day-to-day operations.

These procedures for committing venture capital accomplish several things:

- A written request for funds provides a concise, complete project description. Responsible individuals can tell exactly what is proposed and how it will affect their activities.
- The request gives information that will justify the expenditure. A project should not be started just because it is a good idea. It is necessary, whenever possible, to put down on paper just how many dollars will be added to the company's income and how this compares with the required investment.
- An appropriation request provides a check list of items to be included in estimates of cost and return. Preparing these estimates is difficult at best and the company must be sure that all factors are included. There are a multitude of special cost items that, when overlooked, nibble away at corporate profits.
- The request provides information for company financial planning—required so that funds will be on hand when needed.
- Approval procedure permits authorized individuals to exercise their delegated responsibility for expenditure of company resources.
- Regular status reports allow management to monitor progress and boost projects along if they appear to lag.
- These regular reports also call attention to projects that are getting out of line financially. If a project shows signs of exceeding the authorization, steps can be taken to reverse the trend. If necessary, supplementary funds may have to be appropriated, or the project dropped, before too much damage is done.
- Procedure also spells out the steps for closing completed appropriations promptly. This permits an early start on depreciation and amortization allowances. It also cuts down on loose ends.
- And the procedure provides for comparison of actual project cost and return with the estimates in the appropriation request. These comparisons are useful for improving appraisals of future requests and checking to see that everything possible is done to achieve the forecast profitability of current projects.

When Appropriation Requests Are Needed

Most companies prepare appropriation requests for any expenditures to be capitalized. In general, therefore, they cover all acquisitions that have a life of over a year. Tangible expense items are included along with associated nontangible expenditures for such things as engineering, labor, know-how, permits. Minor items are excluded, with company accountants determining what should be expensed.

In general, projects submitted for construction approval should be well defined, to a point where completion of engineering cannot be expected to increase the accuracy of the capital cost estimate by more than 5%. This requires complete, thorough preliminary engineering for the project, but not the preparation of any detailed design drawings.

How to Prepare Requests

A typical form for submitting appropriation requests is shown in Table I. The graph on the form shows return on investment for three selected production rates. Arrows indicate expected sales for the first, third and fifth years. Point at zero return is the breakeven point.

Many entries on the form may be omitted for smaller appropriations, and attachments added for major ones. Common sense has to be applied in liberal doses when determining the amount of necessary detail. Presentation should be as simple as possible, consistent with the complexity of the project.

This single-sheet form consolidates all key information required to make intelligent decisions on approving or rejecting a project. Attachments merely supply details substantiating key data on the summary sheet. In presenting an appropriation request to groups such as an appropriation committee or board of directors, data can be put on flip-charts, with a separate card for each section.

Attachments Supply More Details

Attachments are added as required for particular projects.

Cost Estimate—Any cost estimate should have as much detail as is consistent with the status of engineering design. (See *Chem. Eng.*, Mar. 7, 1960, p. 113 for estimating methods.)

When estimates are not prepared in detail because design is very preliminary, they should show distribution of costs to primary sections and, where possible, to subdivision groups, as described in the *Chem. Eng.* article referred to above. Subaccount numbers are needed for any items scheduled for early purchase.

Estimates should be either prepared or reviewed by the group responsible for construction. This uncovers omissions at an early stage and permits the construction group to do some preplanning. It also improves validity of the estimate as a project control.

Accounting Information—The upper section of the accounting information sheet (Table II) details the makeup of gross investment, cash investment and ap-

Table I **REQUEST FOR APPROPRIATION**

Date to Committee	Appropriation Number		
Aug. 1, 1959	06	41	4120

Division, Department or Subsidiary:	Location:	Plant:
Chemical	Chicago	Ore Roasting

Descriptive Title: 50 Tons/Day Kiln for New Ores

Appropriation Amount: $440,000

Purpose: Provide 50 tons/day of roasting capacity to convert new-type ores uncovered at Northwest Mines to saleable product.

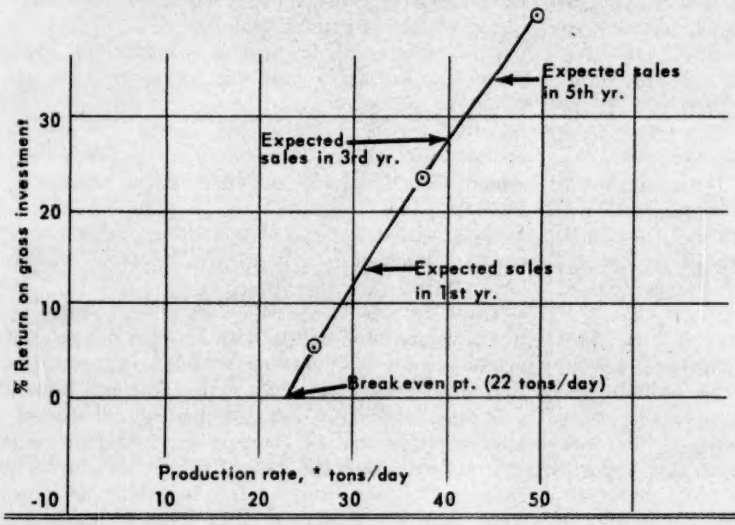
Summary Description: Remove existing No.1 kiln, accessories and foundations. Install new kiln to roast high-yield ores using knowhow from Ware Institute of Research. Product to be sold to extraction companies in the Chicago area.

Project Type	Std. to Co.	New to Co.	Novel
Raw Material			✓
Process			✓
Product		✓	
Packaging	✓		
Sales		✓	

Capital Estimate Summary*	
Gross Investment	$722,000
Cash Requirement	$497,000
Reserve included	20 %

Cumulative Cash Flow**	
1st Yr.	$148,000
2nd Yr.	348,000
3rd Yr.	595,000
5th Yr.	1,178,000
10th Yr.	2,291,000

Justification: New ores being obtained from our mines cannot be handled by existing kilns. When properly roasted by a newly developed process, can be converted to a highly saleable product. Return favorable.



Target Rate of Return for this type of investment ** 14 %

Interest Rate of Return**, 10 yr. life, estimated ** 25.2 %

Prepared by:	Date	Recommended by:	Date
R. J. Collins	6/30/59	B. L. Byers, Div. Mgr.	7/12/59
Checked by:		**Recommended by:**	
J. L. Johnson	7/4/59	App'n Comm. per J.B.L.	8/1/59
Sales concurrance:		**Approved by:**	
B. D. Ross	7/6/59	R. C. Ruth	8/6/59

* Indicates no entry required for projects under $25,000. ** Indicates no entry for projects under $250,000. Attach where appropriate: Accounting information sheet, cost estimate, flowsheets, extended description, market forecast, manufacturing cost, return estimate, risk rating.

propriation amount for the project. The definition of these items and methods of computing them are discussed later.

Facilities to Be Transferred or Retired—This section of the accounting information sheet should be completed when appropriate. It includes all existing company assets used exclusively by the project and all assets forceably retired because of the project.

Information must have enough detail so facilities can be identified and a basis established for proper accounting treatment. Transferred and retired items should be listed and totaled separately.

Market Information—Appropriation requests for producing new products or expanding existing production when an investment of over $250,000 is involved should be accompanied by market information covering all products and byproducts.

Reference should be made to detailed reports and other sources, such as divisional sales forecasts. Where applicable, and in detail proportionate to the importance of the project, the following information should be provided in summary form:

- Estimated volume and rate of growth of sales.
- Estimated prices and anticipated price changes.
- Competitive producers, existing and potential.
- Competitive products, existing and potential.
- End uses, breadth and location of market.
- Sales, distribution and service methods.
- Seasonal and weather effects.
- Penetration of market, existing and potential.
- Other pertinent information.

Such information should be brief and simple for moderate plant expansions of well-established products, increasing in detail and scope for the larger and more novel projects. Difficulty of making price and volume forecasts is well known, and it will often be necessary to quote ranges. It is also understood that much of the market information will be qualitative. The collection and condensation of all available information, however, will assist management in appraising the project's potential.

Estimated Manufacturing Cost for Added Production—This attachment is prepared for projects exceeding $25,000 when new manufacturing costs will be established or when existing costs will be materially affected by the project. (See *Chem. Eng.*, Apr. 17, 1961, p. 181, for details concerning preparation of this data.)

Estimated Increase in Income and Return—This information is prepared for projects exceeding $25,000 when the company's income and return will be materially affected. Data is used in plotting the return chart on the summary sheet of the request. (See forecasting income and return section of this report.)

Profitability—For major projects (over $250,000), computations for cumulative cash flow, target rate of return and interest rate of return are attached. See profitability and risk section for details and examples (p. 157).

Other Attachments—If the project is a major one, requiring a project management group to supervise design, procurement, construction and startup, a preliminary table of organization and a construction schedule are attached. Projects of this size also justify preparation and attachment of operating tables of organization and a startup schedule. Other material in support of the request is attached as required.

Charts for Control of Capital

Two types of reports are required for control of appropriations.

The first is the monthly analysis of appropriations. The purpose of this sheet, and the supplementary cost and progress sheet, is to provide an accurate picture of project status promptly at the end of each month so that difficulties may be anticipated and early action taken. When properly prepared and promptly distributed, the monthly analysis of appropriations provides excellent management control for the time and money phases of capital projects.

The second control involves performance reports. These are necessary only for larger projects (over $250,000). The capital performance report is prepared two months after project closing. The operating performance report is prepared after the elapse of enough time for dollar return from the project to be considered stabilized. Usually a time limit of two years after project completion is set, with a second report submitted at a later date if stable conditions have not yet been reached.

These reports compare actual project cost, execution time and profitability with forecast figures. Their prime purpose is improvement of future forecasts and they must be kept entirely impersonal and factual.

It must be remembered that the original request for appropriation was an attempt at the fortune-teller's role of predicting the future. There should be little surprise if actual results fail to be exactly as forecast.

We will now discuss some of these forms in detail.

Determining Investment

Questions that come up: What is gross investment? Appropriation amount? Cash requirements? Operating expense?

Computing actual investment in a large project is not a simple matter. Many factors must be considered, each in a consistent way, if forecast profitabilities for various proposed projects are to be comparable.

Investment in a major project should be viewed in three separate ways in appraising its impact on a company's finances and financial records.

The first, the long-term view appropriate for profitability analysis, involves determining the project's gross investment. This is the value of all company resources devoted to the project. It includes not only funds directly expended for construction, but also:

- Value of items already owned and transferred to the project's use.
- Operating costs directly related to construction.
- Funds to be tied up in working capital.
- Allocation of general facilities and utilities serving this and other production units.

• Value of installations destroyed because of the project.

• A reserve, which may or may not be used.

A second viewpoint considers only immediate dollar commitments for the project. This is the project's cash requirement and it is usually less than gross investment. For example, some necessary equipment may be already on hand that can be used without cash outlay. It may not be necessary to provide new cash to build roads or other general facilities, even though the project cannot function without them. (From a long-term viewpoint, roads must be charged by a general facilities allocation.) However, this particular project may trigger an unavoidable cash requirement for a new boiler, office building or set of pipe-racks that could not, in fairness, be charged entirely to the current project's gross investment. Cash requirement may, therefore, be substantially greater or less than gross investment. Primary use of this figure is in planning for capital funds.

The third method views investment with respect to the portion of the total that can be effectively recorded and controlled by those responsible for carrying out the project. This appropriation amount includes direct investment, operating expense that will be charged to the appropriation, book value of items transferred for the project's use, cash to be spent for utilities and general facilities, and other similar items. It does not include tax credits or working capital or allocations, since these are usually outside of the control of the project group. Appropriation amount, therefore, is the target investment that can be controlled during the project's progress. For this reason, it also does not include the reserve, which is a part of gross investment and cash requirement.

Accounting Data on Separate Form

An accounting-information form with sample entries showing how project investment is made up is illustrated in Table II. This is the important second sheet attached to almost all appropriation requests. Each entry will be discussed in detail.

In tabulating these investment items, all figures should be rounded to the nearest $100 ($1,000 for large projects). They should be adjusted so gross investment, cash requirement and appropriation amounts are rounded to three significant figures.

Table II ACCOUNTING INFORMATION

Date to Committee: Aug. 1, 1959 | Appropriation Number: 06 | 41 | 4120

Division, Department or Subsidiary: Chemical | Location: Chicago | Plant: Ore Roasting

Descriptive Title: 50 Tons/Day Kiln for New Ores | App'n. Am't.: $440,000

Investment Required	Gross*	Cash*	App'n. Am't.
Direct Capital Investment	$ 320,000	$ 320,000	$ 320,000
Supporting Utilities & General Facilities	(alloc.) 66,000	(cash) 18,000	(cash) 18,000
Transfer of Existing Capital Items	(value) 50,000	–	(book) 32,000
Operating Expense	20,000	20,000	20,000
Forced Retirements	(value) 95,000	(salv.) 5,000	–
Less: Tax Credit @ 52 % of $20,000 + $45,000	(34,000)	(34,000)	–
Working Capital	35,000	35,000	–
Other Items: Know-how purchase	50,000	50,000	50,000
Subtotal	$ 602,000	$ 414,000	$ 440,000
Reserve 20 % (minimum 15%)	120,000	83,000	–
Total	$ 722,000	$ 497,000	$ 440,000

Facility Number	Facilities to be Transfered or Retired	Year Inst.	Estimated Value	Depreciated Investment	Estimated Salvage	Disposition*
461-20	Firing hood from No. 1 kiln.	'56	$50,000	$32,000	–	T
461-01	No. 1 kiln, installed complete with foundations, piping, wiring and instruments, less firing hood. (Value destroyed $100,000 – 5,000 = $95,000) (Tax writeoff 50,000 – 5,000 = $45,000)	'46	$100,000	$50,000	$5,000	R

Budget Data: To be completed 52 weeks after authorization: Included in five-year plan in the amount of $500,000 cash in 1960. Forecast cash expenditure by quarters after authorization: $100,000, $100,000, $130,000, $130,000, $17,000, plus $20,000 operating expense.

Prepared: B. L. D. | Checked: J. L. V. | Approved: R. B. K.

*Indicates no entry required for projects under $25,000. **T is abbreviation for transfers; R for retirements. This form is not necessary for projects under $25,000 with no facilities or transfer requirements.

Considerable judgment is required in deciding just how much detailed investigation and effort should be applied in estimating various investment components. Individual items, such as inventories, when they bulk large in the totals will deserve much more study and investigation than when they are minor factors. No time should be wasted on elaborate computation and detailed checking of items that cannot appreciably affect project investment.

What Are Battery Limits?

"Battery limit" is a term used in segregating direct from supporting investment. It is that continuous line circumscribed about any project, plant, department or division that encloses and lies at least ten feet outside of all the buildings, structures, equipment, roadways and other facilities dedicated to its sole use. In general, this line will parallel main roads, railroads, pipe racks, plant boundary fences and natural terrain features. The proposed battery limit should be indicated on general layout drawings when they accompany appropriation requests (Fig. 1).

Many times, the product of one unit is the raw material for another. Here, the producing division is considered to include within its battery limit pipelines or other special facilities required to move the material to the battery limit of the using company division.

An appropriation committee should act as an advisory body in making recommendations concerning equitable battery-limit locations.

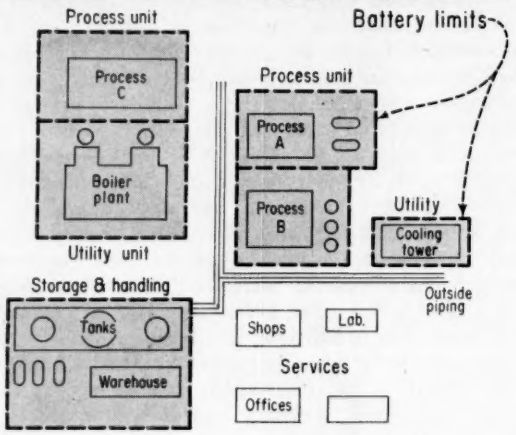
Capital Investment in Battery Limit

Direct capital investment includes all capitalized expenditures for installations within the project's battery limit. In addition to the more obvious items, it includes:

- Value of store items that must be replaced for stock. Issues not to be replaced, however, are considered as transfer items and handled somewhat differently.
- Cost of detailed design and field supervision by associate engineers.
- Cost of detailed design and field supervision by company engineers for major new facilities. Major facilities usually involve more than $100,000 in direct capital investment, exclusive of engineering.
- Cost of utilities and facilities required for the project, within the project's battery limit, are included in direct capital investment. When outside the battery limits, they are supporting utilities and general facilities, and are handled as will be described later in this report.

A cost estimate substantiating estimated direct capital investment is attached to the request. For projects of large size, this estimate may be in summary form, with an item for each major project division. See *Chem. Eng.*, Mar. 7, 1960, p. 113 and Apr. 4, 1960, p. 119, for information and procedures on preparing capital cost estimates.

Figure 1 **Battery limits around unit exclude "supporting" facilities**



For the example in Table I, direct capital investment is $320,000.

Handling Supporting Utilities

Supporting utilities are defined as serving a project but being outside of the project's battery limits. They serve, or are planned to eventually serve, more than one project.

For multiproduct plants, it is desirable for utilities serving the various units to be set up as an independent operating department. This department charges each production unit for utilities used, in proportion to usage, and is charged with all of its own operating expenses, including those related to investment. It is expected to show a modest profit, similar to that of a small private utility company.

Supporting-utilities investment, therefore, is not normally included in gross investment for a production unit. If actual supporting-utility investment is required, its cost is included in cash requirement and in the appropriation amount. This provides a basis for cash-requirement planning and for control of progress and costs on this portion of the program.

Supporting utilities included in the program may be substantially more or less than will actually be required for the operating unit, depending on excess capacity available or the new capacity required in the system. When substantial expenditures are involved, an estimate of the effect on the profitability of utility operation should be attached to the request for appropriation.

When utility investments unrelated to a specific production project are required, they should be on a separate appropriation request, drawn up to show the effects on profitability of the utility's operation. In such appropriations, the utility system is treated like any other producing unit, with allocation of general facilities and so forth.

Utilities include installations for the production,

collection, processing and distribution for general use of the following: Water, steam and condensate, compressed air, electricity, pulverized coal, refrigeration media, natural or manufactured gases, fuel oil.

From Cafeterias to Lighting

General facilities lie outside of project battery limits, and support or are planned to eventually support more than one production unit.

They include the following, when outside limits:

Cafeterias, change houses, docks, fencing, first aid buildings and equipment, garages, guard houses and patrol vehicles, laboratories, land, maintenance buildings and equipment, offices, parking lots, personnel buildings and equipment, pipe racks, planting, railroads, recreation facilities, roads, safety equipment, sewers, sewage treatment facilities, sidewalks, shops, storerooms, track scales, trucks, truck scales, waste ponds, yard lighting.

When a project is served by existing or proposed general facilities, a capital allocation is included in gross investment for the new project, to cover use of these items. Cash requirement and appropriation amount, however, include only actual dollars expended in connection with the current program. This may be either more or less than the allocation. In some cases, adequate facilities are already available to satisfy part or all of the needs of the new process unit. In others, facilities must be built that will serve not only the present unit but planned future units as well.

In the "justification" for such projects, previous and probable future appropriations that include allocations for general facilities in excess of cash requirements should be mentioned.

Transfer of Existing Capital Items

Transfer of existing capital items includes the value of any existing equipment, buildings, piping and wiring that will be transferred from other service or surplus to the new project. Items are normally transferred at depreciated investment value (book value). This value is used in the appropriation amount column of the request. In the gross investment column, however, book value may be increased or decreased in proportion to the actual effective worth of the transferred item when such variation is substantial and acceptably documented.

Surplus and storeroom items not to be reordered for stock are treated as transferred facilities on the forms.

All transferred items are listed on the form (Table II) titled Accounting Information. The facility number on this form comes from property records, and aids in identifying the unit and its records. "Year installed" and "depreciated investment" are also from property records. Depreciated investment includes the depreciated original installation cost if the item is to be left in place. Original installation cost is listed separately as a "retired facility" if the transferred item must be reinstalled for the current project. Cost of dismantling and removing the transferred unit is part of project operating expense. Cost of reinstalling it is part of the direct capital investment in the project.

In the sample accounting information sheet, the firing hood could be sold for $50,000, so this is the value inserted in the gross investment column. The book value of $32,000 is entered under appropriation amount. Funds to dismantle the hood are included in operating expense. Funds to reinstall it are included in direct capital investment.

Project's Operating Expense

Operating expense, as used in investment computation, includes any extra operating dollars spent on construction and starting up of the project. Operating expense is detailed in the cost estimate attached to the request and is set out as a separate item or group of items in the cost-estimate summary. The company's accounting department should be consulted in cases of doubt as to whether specific items are expense or capital.

Some typical items of operating expense for a project are:

- Site clearing. Removal of existing buildings, equipment, foundations, piping, conduit, timber, brush, rubbish, stored material and other items that would obstruct the new installation.
- Temporary process connections and enclosures. This is temporary work required to keep existing equipment in safe, reliable production during construction of new facilities.
- Repairing, relocating and reconditioning existing structures. This includes any cleaning, painting, dismantling, repairing and reassembling required to put existing facilities into good operable condition. Modifications that will result in substantial increases in life, capacity or efficiency must be capitalized and are not included in operating expense.
- Startup costs. For very large projects (over $1,000,000) and for novel projects, startup costs are usually large enough to warrant estimation and inclusion in gross investment. They include operator training, operating manual preparation, startup overtime premiums, special meals and transportation during startup.

Not included in startup costs are any modifications made to increase the life, capacity or efficiency of the unit beyond that intended in the design. Startup costs are included in gross investment and cash requirement, but not in appropriation amount, since necessary funds are expended through the operating budget and normally are not controlled by the project group.

- Extraordinary production and sales costs. These are included in operating expense of the project where they cause actual out-of-pocket losses. Profit on lost sales and any additional cost of filling orders from remote or outside sources is included if the construction program has prevented normal operations. Other

unusual operating expenses, such as operating department overtime premiums resulting from construction conditions, are also included.

• Preliminary project engineering. Work to analyze new ventures, to determine whether or not the company can profitably engage in them, is part of the normal operating expense. It is carried in engineering and other departmental budgets, which go to make up administration expense, and does not appear as an item in the operating expense of a specific project. Preliminary engineering includes all work required for the preparation of a preliminary design report.

• Detailed design work by company engineers for minor modifications. This is an item of operating expense. To qualify, modifications must involve existing facilities—and direct investment for the project, exclusive of engineering cost, must be less than some arbitrary amount, usually $100,000. Otherwise, detailed design is capitalized as previously discussed.

How Forced Retirements Affect Investment

Forced retirement of facilities from company service because of an upcoming project has an influence on over-all investment.

Any real value destroyed in this way is charged to the project's gross investment. The normal amount is the depreciated investment or book value destroyed, including residual installation value. A credit is allowed for conservatively estimated resale or scrap value, which may occasionally exceed book value.

Book value is normally assumed to be representative of the actual worth of items. It is reasonably easy to determine, and accurate enough for most situations. In special cases where obsolescence or deterioration has abnormally reduced the value of retired items, or where circumstances have made their actual dollar worth substantially greater than book value, destroyed value should be appraised for economic study at estimated actual value. One measure of actual value is the present, or reasonably probable, net income after taxes from the existing unit, capitalized at, say, 6%. Another measure is sale value to an outsider.

Value of retired facilities destroyed is not included in cash requirement for a project, since no expenditure is involved. Cost of dismantling and removing is part of gross investment, cash requirement and appropriation amount for the project and is included in operating expense. Salvage expected from the sale of retired facilities is handled as a credit to cash requirement. It also serves to reduce the value destroyed in the gross-investment column.

In the sample accounting information sheet, estimated installed value of No. 1 kiln, less the transferred firing hood, is $100,000. In other words, the kiln in its present condition and service is considered to be worth more than the $50,000 book value. The $100,000 value less $5,000 estimated salvage, i.e., $95,000, goes into the gross-investment column. The $5,000 salvage is a credit item in the cash column. Cost of tearing out the kiln is part of a $20,000 operating expense.

Don't Forget Tax Credit

Tax credit is the amount that income tax is reduced because of any retirement losses or special operating expenses incurred in connection with the project. Because incremental effect is considered, credit for most corporations is assumed to be 52% of operating-expense items, plus tax credit for the loss on items physically retired because of the project.

Estimating the tax effects of retirements is sometimes a complicated matter. The general rules, however, are currently as follows:

• When sale value is less than book value: (1) Item sold as scrap—tax credit is 52% of book-less-scrap value. (2) Item sold as an operable unit—if the company has offsetting capital gains in the same calendar year, tax credit is 25% of book-less-sale value. Otherwise, tax credit is 52%.

• When sale value is more than book value: (1) Item sold as scrap—tax to be paid is 52% of scrap-less-book value. Gross investment and cash requirement are both increased by this tax amount. (2) Item sold as an operable unit—tax to be paid is 25% of sale-less-book value. As before, this item increases gross investment and cash requirement.

Because of the many and changing tax rulings, any important, difficult or doubtful tax situations should be referred to tax experts.

In the example, the kiln retired and sold as scrap has a book value of $50,000. Deducting the $5,000 salvage, there is a $45,000 operating loss. This, added to the $20,000 operating expense for the project, makes a total of $65,000 subject to the 52% tax credit.

Working Capital Easily Overlooked

Working capital is one of the more subtle elements of capital investment and probably the one most easily overlooked. Failure to provide for it is a classic cause of bankruptcy in small and growing businesses.

Working capital is made up of money and goods that must exist in an organization at any given time to enable it to function. Working capital chargeable to a given project is the net increase (or decrease) in the working capital of the corporation as a whole due to addition of the project.

For appropriation request purposes, working capital is the average annual value of all working capital items listed below, assuming operation at 100% capacity. This assumption is only slightly conservative, since working capital usually does not drop nearly so fast as operating rate. In a few special cases, it may be necessary to establish several working capital estimates corresponding to operating levels that will be maintained for a substantial length of time.

Working capital includes:

- Process inventories.
- Supplies inventory.
- Accounts receivable.

• Current liabilities (a credit).
• Other current assets.

Process inventories include inventories at estimated cost—or transfer price if from another company division—of: raw material; in-process material; finished product in storage; product enroute to customers, but not billed; product in customers' or retailers' hands on consignment; stored fuel and stored packaging material.

> ***"Working capital is one of the more subtle elements of capital investments. . . . Failure to provide for it is a classic cause of bankruptcy in small and growing businesses."***

Any one of these items may either be small enough to ignore or so large as to be a major investment item for the project. Inventories deserve special attention when seasonal, high-value or bulk-shipment materials are involved. In such cases, it is a good idea to make a complete analysis of the inventory situation, considering expected production, shipping and sales fluctuations, and the inventory required to meet them. Successful solutions to these problems often require the joint efforts of sales, operating, purchasing, traffic and accounting departments.

The table below gives some indication of inventories in order-of-magnitude figures:

Type of Plant	Raw Material and Fuel, in % of Annual Mfg. Cost at 100% Capacity	In-Process and Finished Goods, in % of Annual Mfg. Cost at 100% Capacity
Heavy chemicals (caustic, soda ash, chlorine)	14 to 19	2 to 4
Sodium silicate	3 to 5	4 to 6
Metallic salts	13 to 22	4 to 6
Cement	variable	10 to 12
Chlorinated products	1 to 5	3 to 19

For the entire chemicals and allied products industry, total inventories have averaged as follows at year end:

	In % of Annual Sales	In Months of Sales
1956	16.7	2.00
1957	17.1	2.05
1958	17.1	2.05
1959	16.3	1.95

Individual plants and projects may require inventories considerably greater or smaller than these averages.

The usual supplies-inventory criterion is total direct capital investment plus replacement value of transferred items. Company experience should be collected and analyzed to determine the ratio between average inventory of supplies and this investment. Usual values in the process industries are on the order of 3%.

The accounts receivable amount varies with type of business and with credit policies. It is usually expressed in terms of months of production and valued at gross sales less profit. The value of product transfers within the company is excluded from gross sales, since accounts receivable do not exist with respect to this portion of production.

Actual average values for the chemical and allied products industry have been:

	Receivables in Months of Sales
1st quarter 1959	1.43
1st quarter 1960	1.45

Current liabilities are included as a credit against working capital. This is money that the company need not possess at a given time, payment not being due, even though goods or services have been received. The amount of current liabilities credit depends on practice in a particular trade, company financial policy and rules for tax payment. It can be estimated as a percentage of total receivables and inventory.

Past experience in similar endeavors is the best guide to the percentage credit to be allowed. For the chemical and allied products industry, percentage of current liabilities to total receivables and inventory in recent years has been as follows:

	% Current Liabilities to Rec. and Inv.
1st quarter 1958	48
1st quarter 1959	44
1st quarter 1960	49

Other current assets are primarily cash on hand or in banks, government bonds or other readily convertible securities. Such funds are necessary to take care of surges in the company's flow of capital. Amount tends to be proportionate to the current liabilities of the company and is affected by company financial policies. For the chemical and allied industries this percentage of cash and government securities to current liabilities has been:

	Cash and Gov'ts. to Cur. Liab.
1st quarter 1958	68%
1st quarter 1959	80%
1st quarter 1960	71%

As usual, a study should be made of company practice and records before estimating this item.

Other Important Items

Other items of investment, particular to a specific project, may include single-sum process or know-how rights, initial catalyst or solvent charges (with a life of over one year, such as mercury charges for electrolytic cells), major uninstalled spare equipment or parts (over $1,000 per item) and any other items of gross investment required for the success of the project. Items of this type often require special treatment with respect to depreciation, as will be discussed in a later section, and therefore must be segregated from the normally depreciable items.

Reserve is an amount by which the project may overrun if a great many things go wrong. It is computed

on a percentage basis, proportionate to the degree of novelty of the project and the extent to which project investigation and engineering have been completed. The procedure for getting this percentage is described in *Chem. Eng.*, Apr. 4, 1960, p. 123.

In no case should the reserve be less than 15% of the subtotal of the other items of gross investment or cash requirement. Projects so sensitive to capital investment that they will be unattractive if they have an overrun of 15% are usually not justifiable.

Forecasting Income and Return

To get income and return, you have to estimate sales, distribution and manufacturing costs.

Income and return are two of the most important items used in appraising a new project. Both are computed on an annual basis as shown in Table III on p. 155.

In setting up a standard arrangement of data, existing recording and reporting practices should be considered. And once established, the "standard" should be used throughout the company so that presentations can be easily understood and compared by everyone concerned.

All data are incremental and represent economic changes produced by the project as realistically as possible. Temporary incremental advantages must be handled as such. The study's purpose is to forecast economic effects over the full life of the particular project.

These incremental return economics will not always coincide exactly with returns reported in regular monthly reports for operating control. Such reports show status after project completion, not changes produced by the project.

Income and return results are plotted on the graph in the lower section of the appropriation request summary sheet. Additional points are computed if necessary, to define the curve.

How Sales Affect Costs

Sales-increase effects are most important when evaluating a project. They are, also, most difficult to estimate.

Spaces are provided in Table III for tabulating products that will be made and their expected sales prices. All products, byproducts and major wastes should be noted. Special attention is required for byproducts. Their price and sales volume are often very hard to predict and may have a controlling effect on the profitability of the project.

The accounting department can provide sales prices for products the company is currently selling. These may or may not be list prices. If the product is one the company is now buying but will be producing in the future, a good purchasing department can provide information on going prices. Sales taxes should be deleted from these figures. For items the company neither sells nor buys, preliminary information can be obtained from the *Oil, Paint, and Drug Reporter* and from the quarterly price issues of *Chem. and Eng. News*. These sources give general information and should never be used for construction authorization.

A check should be made for possible uses of any major wastes resulting from a proposed project. Potential development and suggested research in this direction should be noted at the bottom of the sheet if such possible income is not reliable enough to be included in the tabulation.

An excellent source of information on market-research methods, together with a very complete listing of sources for prices and other market data: sections 5 and 6 of "Chemical Business Handbook," edited by John H. Perry, McGraw-Hill, 1954.

In many cases, your company's sales or commercial development department will have information on prices and volume at which new products may be sold. A resume of information, prepared by the originating parties, should be included in the appropriation request.

For all projects over $25,000 that involve return computation, increase in sales is estimated for the first, third and fifth years. Production levels for each of these years are shown by arrows on the return curve of the summary sheet. For projects over $250,000, sales price and volume are forecast for each year of project life, before calculating interest rate of return. (To be discussed in the next part of this report.)

Calculating Distribution Costs

Distribution costs include equalized freight, freight taxes, allowance for returns, absorbed freight, warehousing costs, import duties (less drawback) and other expenses related to physically moving the product to the purchaser.

Equalized freight is the difference between (a) freight from the actual manufacturing point to the customer and (b) freight from the customer's basing point to the customer. Basing point is a producing plant nearest the customer, whether or not owned by the company. In many cases, therefore, the company's own plant may be the basing point and no equalization is required.

Some process products, such as plastics, are sold on the basis of free delivery to the customer, rather than what is essentially free delivery to the customer's basing point. In these cases, the entire freight from producing point to customer is paid by the company. This is absorbed freight. Assistance in determining

Table III **ESTIMATED INCREASE IN ANNUAL INCOME & RETURN**

Appropriation Number: 06 | 41 | 4120 — Supp.

Title: 50 Tons/Day Kiln for New Ores

Sales Rate, principal product					
Added Tons of Roast / Yr.			17,500	13,130	8,750
Added in % of added capacity			100 %	75 %	50 %
Total sales rate Same					
Total rate in % of new total capacity			%	%	%
Increase In Sales					
	Price	Units			
Hi - roast	$1.20	T	$ 2,100,000	$ 1,575,000	$ 1,050,000
Slag (0.6 T/T Hi-R.)	$3.50	T	36,800	27,600	18,400
Kiln dust (0.05 T/T Hi-R.) [1]	-		-	-	-
Total increase in sales			$ 2,136,800	$ 1,602,600	$ 1,068,400
Increase in Distribution Costs					
Freight equalization Only producer					
Warehousing None					
Total increase in distribution costs			$ 0	$ 0	$ 0
Increase in Net Sales			$ 2,136,800	$ 1,602,600	$ 1,068,400
Increase in Manufacturing Cost (from Added Manufacturing Cost Sheet)			$ 1,346,000	$ 1,092,000	$ 826,000
Increase in Gross Profit			$ 790,800	$ 510,600	$ 242,400
Adm., Sales & General Expense (based on net sales less trans. raw mat. @ capacity)					
Hq. 2%, Div. 6.5 % of $1,675,800 [2]			$ 142,800	$ 142,800	$ 142,800
Increase in Net Profit before I.T.			$ 648,000	$ 367,800	$ 99,600
Income Tax					
State -- %			-	-	-
Federal 52 %			337,000	191,000	51,700
Total Income Tax			$ 337,000	$ 191,000	$ 51,700
Increase in Net Profit after I.T.			$ 311,000	$ 176,800	$ 47,900
Return, in % Net Profit after I.T., on Gross Inv. of $722,000			$ 43.1 %	$ 24.5 %	$ 6.7 %

Notes:

[1] Very fine, almost pure silica. No present use known.

[2] $2,136,800 less $461,000, "B" ore from Loco Mines Div.

Prepared by:	Date	Checked by:	Date
P. J. P.	6/29/60	R. P. E.	6/29/59

equalized and absorbed freight can usually be obtained from traffic and accounting departments. Railroad assistance is also available. Cost of warehousing can be determined from standard cost tabulations or by separate computation when required. Reference is again made to Perry's "Chemical Business Handbook" for general information on distribution costs.

Net sales is total income from sales less distribution costs, as described above.

Need Manufacturing Costs

For a discussion of manufacturing cost, see *Chem. Eng.*, Apr. 17, 1961, p. 179.

Manufacturing cost is not the same as cost of sales. Cost of sales is manufacturing cost for a given period, plus or minus manufacturing cost of any products drawn from or added to inventory. Since return estimates for appropriation requests cover a full year, it can usually be assumed that inventory effects cancel out and manufacturing cost equals cost of sales for the typical year.

Gross profit is net sales less manufacturing cost.

Administrative, Sales and General Expense

A major company overhead item comes under the heading of administrative, sales and general expense (A.S.&G.). This includes: cost of general company management, accounting, purchasing, personnel service, traffic, sales advertising, public relations, engineering (portion not capitalized), research, development, corporate taxes (other than income taxes), office expense, interest on corporate debts* and all other items of general corporate expense. State income tax is sometimes included, although if significant it should be a separate item in the return tabulation.

A. S. & G. expense is, in general, proportionate to net sales, the percentage tending to be less for large corporations than for small ones. For a process company of moderate size, whose principal sales are to other manufacturing companies, incremental A. S. & G. may be about 8% of net sales. The figure will be substantially larger when direct selling to retailers, consumer advertising or heavy research expenditure is involved.

For new products that will have continuing promotion costs not consistent with established products, a separate calculation of advertising and selling expense should be made.

In a divisionalized company, separate A. S. & G. determinations are necessary for headquarters and for each division. The headquarters portion may be 2-3%, depending on how individual items are assigned by accounting, the nature of the business, and management policy. Variations between individual divisions of a company will come from the same sources that produce variations between individual companies. Percentages can range from 3% for a large well-established bulk-product division to about 25% for a small, newly established division serving many customers.

In analyzing and computing A. S. & G. by percentage of net sales in a divisionalized company, the value of any raw materials from other divisions is deducted from the divisional net sales figures. This eliminates pyramiding of overheads. It also, in an approximate way, gives credit to the using division for eliminating outside expenses connected with sales and special services.

In deriving percentages to be used for A. S. & G. estimating, the net sales of the company or division operating at full capacity should be used as a base. For the new unit, such percentages are applied to net sales at 100% capacity. These A. S. & G. data are assumed constant over the range of operating levels presented. Such an assumption is reasonably correct, since low operating levels often demand added sales, advertising, research and other headquarters activities, which balance the items that can be cut as production goes down.

Correct Levels for A.S.&G.

A. S. & G. percentages show interesting patterns when plotted over a period of time. Major capacity additions normally will decrease the percentages when units first come into production, but percentages drift back upward as time goes on, stabilizing at a new level somewhat below the one preceding the addition. Management changes have their effect. A new manager for an established, profitable division usually can decrease A. S. & G. by trimming "soft" practices. A new manager in a faltering division, or company, is likely to increase A. S. & G., as he pushes sales, advertising or research effort.

Correct A. S. & G. levels are a matter for decision by the best management opinion available. In many companies, these expenses could be cut, so that immediate profits per share would appear to double. Future profits are jeopardized by such action, however, since it involves cutting research, advertising, engineering and so forth. These are the tactics of the company raider. They contrast with more conservative practices that build up hidden assets of good-will, elite personnel, research potential and public acceptance. Management can therefore be a substantial factor in forecasting A. S. & G.

Net profit is gross profit less administrative, sales and general expense.

Net profit less state and federal income taxes must also be calculated. Incremental federal income tax is 52% at present for all but the smallest process companies. State income taxes are variable and specific state regulations must be consulted. If the state tax is minor, it can sometimes be included in A. S. & G., even though it is more correctly a function of net profit.

* The handling of interest on indebtedness, used here, assumes that the corporation obtains its funds from a relatively fixed mix of common stock, retained earnings, loans and other forms of indebtedness. Each project pays its proportionate part of the interest cost of obtaining money, with no regard to the actual cost of obtaining funds for the particular project. This assumption is reasonably correct if the funds are obtained in normal fashion and the mix of ownership and indebtedness is not seriously disturbed. Special handling may be required for joint ventures and other cases involving stock or bond issues.

What Is Return?

The return of a project at a given level of operation is the percentage of annual net profit after income taxes, using gross investment as a base for calculations.

Return for each of the three selected production levels is plotted against production rate on the graphical insert of the summary page of the request for appropriation. Shape of this curve is an indication of project sensitivity to variations in sales. Arrows are placed on the curve to show expected sales for the first, third and fifth years. The general elevation of the curve is an indication of return at varying sales levels. Point of zero return is the breakeven point for the project.

Profitability and Risk

Acceptance or rejection of a project hinges on interest rate of return at a given risk.

Return is a measure of the profit potential of a project at a given level of sales. But for important projects, it is desirable to have a broader measure for profitability; one that indicates net effective profitability of the project over its life span. This must take into account not only the return at a given level of sales, but what sales volume and price levels are likely to be, and over what period of time they will be maintained.

Obviously, this is a more difficult determination to make, and there is still much discussion about the various techniques used. The extra work involved can only be justified for projects of considerable importance to the company.

Interest Rate of Return Easily Understood

In the author's opinion, interest rate of return is the most easily understood and technically correct method of supplying a single figure indicating project profitability.

In using this method, the project is examined just as a banker considers a mortgage he is taking on a house. The banker sets up a mortgage so that at all times during its life it will return to him a suitable fixed interest on the unpaid balance of the loan. The owner has the privilege of paying on the capital amount of the loan from time to time, but always must pay interest on the unreturned balance.

Similarly, a company can value a project in terms of a constant annual rate of interest that will be produced on the unreturned balance of investment during a project's life. Any money netted by the project in excess of this constant annual "interest rate of return" is credited against project investment.

Interest rate of return is set so investment is reduced to zero at the end of the project's life. This interest rate on unreturned balance is an excellent measure of net effective project profitability.

Need Trial-and-Error

Interest rate of return must be determined by trial-and-error. For each year, estimates are made of any capital investment required and of net cash flow that the project will produce. Net cash flow is total sales income less total expenses paid out. The latter includes A. S. & G. and income taxes but not depreciation, since depreciation does not produce an outflow of cash.

A reasonable interest rate of return is assumed. Starting with the first year, the project is charged with interest at this rate on the unreturned balance of company funds invested in the project at the middle of the year. Any excess of funds received by the project and not required for this interest, or for normal expenditures, is in effect paid by the project to the company to reduce the unreturned balance.

Continuing this procedure, as indicated in Table IV, a year is reached when the entire investment, plus interest at the assumed rate less the salvage value of plant and working capital, has been returned to the company. If time to accomplish this is less than the estimated life of the project, then the assumed interest rate is too low. A higher rate is assumed and the procedure repeated. Three trials, plotting percent inter-

Figure 2 **Interest-rate-of-return curve gives true rate for 10-yr. life**

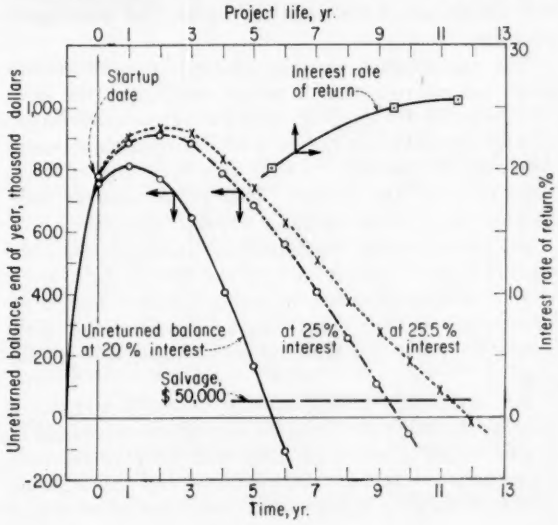


Table IV Trial-and-error computer calculations

Yr.	COL. O Output Tons/Day	COLUMN S Net Sales, (Gross Sales less Dist. Cost)[1]	COLUMN M Mfg. Cost less Ave. Dep. plus A.S. & G.[3]	COLUMN D Depreciation Sum-of-digits %	COLUMN D Depreciation Sum-of-digits $	COLUMN P Net Book Profit Before Fed. In. Tax (S-M-D)	COLUMN T Income Tax, 52% of P	COLUMN F Net Cash Flow (S-M-T) or (P-T+D)	COLUMN I Investment by Company
	0	0	0	0	0	0	0	0[9]	$687,000[4]
1	30	1,280,000	1,040,000	18.2	64,000	176,000	92,000	148,000 148,000[9]	35,000[5]
2	35	1,500,000	1,146,000	16.4	57,700	296,000	154,000	200,000 348,000	0
3	40	1,710,000	1,250,000	14.5	51,000	409,000	213,000	247,000 595,000	0
4	45	1,920,000	1,358,000	12.7	44,800	517,000	269,000	293,000 888,000	0
5	45	1,920,000	1,358,000	10.9	38,400	524,000	272,000	290,000 1,178,000	0
6	45	1,920,000	1,350,000	9.1	32,000	530,000	276,000	286,000 1,464,000	0
7	45	1,920,000	1,358,000	7.3	25,700	536,000	279,000	283,000 1,747,000	0
8	45	1,820,000[2]	1,358,000	5.5	19,400	443,000	230,000	232,000 1,979,000	0
9	45	1,720,000[2]	1,358,000	3.6	12,700	349,000	181,000	181,000 2,160,000	0
10	45	1,625,000[2]	1,358,000	1.8	6,300	261,000	136,000	131,000	0[6]
		17,335,000	12,942,000	100	352,000	4,041,000	2,102,000	2,291,000	-50,000
11								131,000	
12								131,000	

[1] From curve plotted from data on annual income & return sheet.
[2] Assuming price competition in latter years.
[3] From curve plotted from data on manufacturing cost sheet (Chem. Eng., April 17, 1961, p. 181).
[4] Gross investment less working capital, assumed spent over one year prior to startup.
[5] Working capital.
[6] Salvage, at end of 10th year, of working capital and scrapped plant.

est rate vs. time to return investment, are usually sufficient to establish a true rate for the expected project life (Fig. 2).

Interest rate of return for the project is noted on the initial, summary page of the request for appropriation.

The relationship between return on gross investment and interest rate of return depends on the sales level selected for quoting return on gross investment. It might be said that the sales level producing a return equal to the interest rate of return is the effective sales rate for the project. This is not strictly true, because the percentage bases are quite different.

For return-on-gross-investment computations, the base is a fixed investment over the life of the project. For interest-rate-of-return calculations, the base is an unreturned balance that usually rises in the early stages of the project, drops to salvage value at the end.

An excellent cost-engineering research project is possible in this area. Interest rate of return should be computed for a series of cases with varying relationships between unit gross investment and annual sales, and with varying ratios of unit manufacturing cost to sales. The resulting curves should be illuminating.

Cumulative Cash Flow

Cumulative cash flow is developed as indicated in Table IV and tabulated for key years on the summary page of the request. Negative values mean that financial planning must include a cash provision to cover operating losses in early years.

Also from a financing viewpoint, cumulative cash flow indicates when the project may be expected to complete the return of cash required for its execution.

Computers Permit Detailed Analysis

Although the theory of interest rate of return is simple enough, its practical application involves much laborious computation. This is especially true because:

- Best results are obtained if individual sales and expenditure figures are established for each year of project life, considering the expected pattern of growth of sales and deterioration of price with competition.
- Most firms use a policy of depreciation that writes off properties rapidly in early years. This

yield interest rate of return for 50 tons/day kiln

20% INTEREST			25% INTEREST			25.5% INTEREST		
R	C	B	R	C	B	R	C	B
Interest Returned $\frac{B_1+B_2}{2}\times 20\%$	Capital Returned (F-I-R)	Balance Unreturned[7]	Interest Returned $\frac{B_1+B_2}{2}\times 25\%$	Capital Returned (F-I-R)	Balance Unreturned[7]	Interest Returned	Capital Returned (F-I-R)	Balance Unreturned[7]
76,300	-763,300	763,300[9]	98,300	-785,300	785,300[9]	100,500	-787,500	787,500[9]
157,100	- 44,100	807,400	208,000	- 95,000	880,300	214,000	-101,000	888,500
157,300	42,700	764,700	223,000	- 23,000	903,000	230,000	- 30,000	918,500
142,500	104,500	660,200	224,000	23,000	880,000	232,500	14,600	903,900
106,800	186,200	408,000	210,000	83,000	797,000	221,500	71,500	832,400
58,500	231,500	176,500	186,500	103,500	693,500	201,000	89,000	743,400
7,500	278,500	-102,000	157,200	128,800	564,700	175,300	110,700	631,700
- - - - - - 5.5 yr.[8] - - - - - - -			120,000	162,200	402,500	143,400	139,600	492,100
			81,800	150,200	252,300	110,100	122,000	370,100
			46,200	134,800	117,500	81,700	99,300	270,800
			14,700	116,300	- 49,200	60,000	71,000	199,800
			- - - - - - 9.4 yr.[8] - - - - - - -			39,200	91,800	107,600
						12,300	118,700	- 11,100
						- - - - - - 11.5 yr.[8] - - - - - - -		

For 10 yr. life, interest rate of return = 25.2%.

[7] $B_2 = \frac{B_1(1+r/2)+I-F}{1-r/2}$ where r is the selected interest rate. Solve for B_2, compute R and correct B_2 to fourth significant figures. B_2 also = B_1 - C

[8] Plot "balance unreturned" to interpolate to fractional years (Fig. 2).

[9] Totals at end of each year.

means that the allowance for depreciation, and therefore income tax, will be different for each year, even if all other items are constant.

• The dollar interest return to the company for an individual year is the interest rate of return times the average unreturned investment for the year. Investment at the first of the year is known, but year-end investment depends upon payment the project is able to make on the principal amount during the year. This complicates the arithmetic.

• Computation of payout time for at least three interest rates is usually required to determine interest rate of return for the assumed project life.

Although a correct solution to interest rate of return can be turned out by any trained engineer or accountant doing hand calculations, the procedure is quite time consuming so the job is best turned over to a computer.

For major projects, it is a good idea to put all the project economics, not just the interest rate of return, on punch cards. In this way, the entire manufacturing cost, net profit and interest rate of return computation can be carried out rapidly by a preprogrammed computer, once it has the basic project information. Improved data can be substituted for earlier assumptions with little difficulty. Special studies can readily be made on the effect of variations in particular elements of the project, such as process yield, labor rates, investment or project life.

Computer Techniques

Computer programming for manufacturing-cost and net-profit computations has been developed by several chemical process companies (Diamond Alkali, Dow, Monsanto, Columbia Southern). An engineer makes appropriate entries on a form, corresponding cards are punched, and the program run. Runs can be made with input data for each successive year of project life, to arrive at net cash flow. This can be further programmed to determine interest rate of return. Complete print-outs of key data can be made for inclusion in reports. Curves can also be produced showing the effects of changing various elements of the project. The programming of these computations can be a lifesaver when last-minute significant changes must be made in presentations.

Consultants are available and should be used to cut

Figure 3 Typical target rates of return for various risk projects

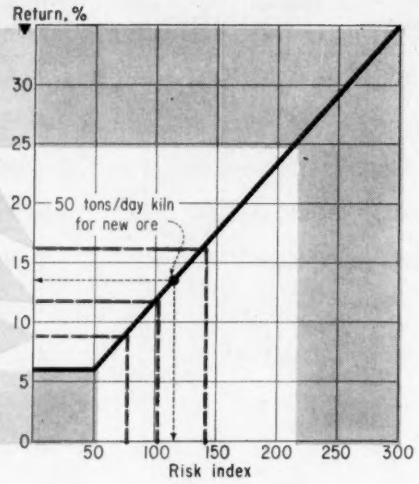
High risk. Projects involving considerable novelty or based on raw material, products, sales data somewhat unproved. Risk rating is 220 and up, return should be 25% and up.

Fair risk. Projects somewhat outside the present field of activity, or novel projects and processes that have been thoroughly investigated. Risk rating is about 140, with a return of 16%.

Average risk. Usually projects in present field of operations, but involving some novel element or lack of definite market information. Risk rating is about 100, with a 12% return.

Good risk. These are often expansions of existing operations where there's a known market. Risk rating is about 75, with a 9% return.

Excellent risk. These projects usually are designed to improve yield or reduce labor costs on a known process. Usual risk rating is under 50, with a target rate of return of 6% or less.



the substantial cost of adjusting existing computer programs to a particular company situation. If computer time is not available on company machines, it can be rented from computer service companies or from other industrial companies with idle computer time.

Once a program is established, the solution of individual problems is a straightforward matter, best handled by a company's own cost-engineering section. By direct handling of its own computation, any company will be able to wring the ultimate in project analysis from the computer program.

Despite its computation complexities, interest rate of return is a simple, precise and inclusive criterion of project profitability. It consolidates, in one figure, a broad array of information and relationships affecting profitability. The complexity of the procedures required to reach this single figure is due to the conditions under which modern industry operates and not to the method itself. Failure to consider some of the complex facts of industrial life is common. The result has often been glowing profit predictions, followed in many cases by hard-won, commonplace returns.

Risk Measurements Are Difficult

In selecting projects, consideration of apparent profitability is not enough. The risk of not obtaining this profitability must be considered.

High-risk projects should have correspondingly high returns if they are to be accepted in lieu of low-return, low-risk projects. Some criterion is required, however, for "high" and "low" in project-risk appraisals.

Measuring risk is difficult. The rating method suggested here is of the check-list type. It assumes that the possibility of failing to reach the apparent profitability of a project is a function of:

- Inherent reliability, for the particular project, of each of the items that can have a major effect on profitability.
- Degree to which each of these items has been investigated.

A project-risk-rating form is illustrated in Table V. The list of items includes these that have a major effect on profitability for process projects, excluding those that affect investment and have already been considered in establishing the investment reserve.

Space is provided for summary notations of project conditions. Inherent risk and investigation status are rated "excellent" through "poor," or with corresponding numerical ratings of one through five. Multiplying the inherent risk and investigation ratings gives a risk index for each item. Total risk index for items in the market group is doubled, reflecting its importance. The grand total is a measure of over-all project risk.

Target Rate of Return

The relationship of a given degree of risk to acceptable interest rate of return is a matter of management policy decision. The curve (Fig. 3) illustrates a typical pattern for target rate of return vs. risk index.

For minor projects, target rate of return can be approximated by a simple description. For major ones, a check list helps to determine risk index; target rate is then read from the curve. This is entered on the summary sheet of the appropriation request, for comparison with the interest rate of return forecast for the project.

Needless to say, this detailed review of risk status is justifiable only for important projects. The technique by its nature cannot be precise, but the very act of detailed review is most valuable. Areas requiring more investigation are uncovered. Avoidable risks are eliminated. Unavoidable risks are faced and openly accepted or rejected by management.

Table V

PROJECT RISK RATING

Project Titled 50 Tons/Day Kiln for New Ores — No. 06-41-4120

Date 6/29/59

Rated By R. J. Collins — Checked By J. L. Johnson

Item	Risk Characteristics (4)	Risk Rating (1)	Investigation Rating (2)	Risk Index (3)	
Raw Materials & Fuel					
Source & Transportation	Our mine, Lake Shore R.R.	E	E	1	
Price	Mining costs well developed.	E	E	1	
Quality	May vary. Drilling in progress.	F	F	16	
Hazards & Regulations	None expected; similar to present.	E	E	1	
Subtotal					19
Process					
Yield	Prel. pilot-plant data; may vary.	F	F	16	
Utility, Labor & Supply Usage	Similar to present kilns.	E	G	2	
Patents & Know-how	Search complete. Buying from Ware.	G	E	2	
Obsolescence	Ware working on electrolytic method; negative results to date.	S	S	9	
Subtotal					29
Products & Byproducts					
Quality	Pound samples tested by customer.	S	S	9	
Packaging & Shipping	Similar to present.	E	E	1	
Hazards & Regulations	None expected, except silicosis with dust.	G	G	4	
Subtotal					14
Market					
Competitive Products					
Existing	None known.	E	G	2	
Potential	Other high-ratio halides.	G	G	4	
Competitive Producers					
Existing	None.	E	G	2	
Potential	Others mining similar ores.	F	G	8	
Breadth & End Use	Space projects only.	F	E	4	
Sales & Service Methods	Existing.	E	E	1	
Seasonal & Weather Effects	None expected.	E	E	1	
Penetration Percentage	100% of market.	P	E	5	
Subtotal, doubled (5)				27x2	=54
RISK INDEX, Grand Total					116

Notes:

(1) E, excellent conditions, little risk; G, good conditions, moderate risk; S, satisfactory; F, fair; P, poor; O, not involved.
(2) Use E thru P, as above, to indicate degree of investigation of the item to date.
(3) Product of columns (1) and (2), using numbers 1 thru 5 to replace letters E thru P.
(4) Refer to separate page for comments requiring more than available space.
(5) Doubled to give proper weight to market factors.

Reporting Performance

Keeping tabs on approved projects provides feedback for future improvements in forecasting and performance.

When an appropriation has been approved, it becomes the responsibility of project management to monitor execution of the program for speed and economy.

The principal tool for this is the monthly analysis of appropriations, with its associated cost and progress sheet. The other major tool used to monitor projects is the construction progress schedule, discussed in some detail in *Chem. Eng.*, Apr. 3, 1961, p. 155.

A form used for the monthly analysis report, with sample entries and notes on its preparation, is illustrated by Table VI.

How to Use Progress Sheet

For major projects (over $100,000) analysis of proj-

ect status is economically justifiable, involving a cost and progress sheet (Table VII). Work sheets, covering every subaccount of the appropriation, are prepared in this same form, to obtain data entered on the cost and progress sheet. For very large appropriations, status of each major section of the project is also reported.

Reporting Project Performance

Within two months after project closure, the accounting department should prepare a complete performance report for the capital phases of major appropriations (Table VIII).

Early completion of the report is desirable, at a time when all records are in usable condition and the report can be prepared by personnel completely familiar with the project. Some items, such as unsettled claims, may have to be estimated.

To the report are attached the final subaccount tabulations of material cost, labor cost and construction man-hours. Engineering man-hours are also reported, by project section and class of work.

This is a final, official record that can be confidently used in preparing future plans and estimates for similar projects.

Feedback From Operations

When a major revenue-producing project has been in operation long enough so dollar return is somewhat stabilized—but not later than the second anniversary of project completion—the accounting department should prepare an operating performance report (Table IX). This compares actual project return with return expected when the request for appropriation was approved.

Actual and estimated values are compared for the production level reached during the project's best operating month up to the time of the report.

Table VI MONTHLY ANALYSIS OF APPROPRIATIONS

Division Chemical
Plant/Location Chicago
Month Ending 4/30/60

Approp. No. (1)	Approp. Title (2)	Date Apprv'd. (3)	Expected 98% Completion Date: Per Approp. (4)	Last Month (5)	This Month (6)	Paid for to Date (7)	Expected Total Cost: Reestimate from Cost & Progress Sheet (8)	Per Approp. (9)	Approp. with Supplements (10)	Expected Variance: Over-run Dollars and Percent (11)	Under-run Dollars and Percent (12)	Comments (13)
06-41-4120	50 T/D Kiln for new ores	8/6/59	8/6/60	9/1/60	10/1/60	$459,000	$559,000	$440,000	—	$119,000, 27%	—	Over-run made necessary by new process information. Supplement being prepared.

(1) From appropriation. (2) From appropriation, but abbreviated to a few words. List all active appropriations for this plant. Projects under $25,000 may be eliminated at the option of the Manager, except at the end of the month in which the project is physically completed. (3) From appropriation. (4) From estimate of time of completion after approval, as stated in appropriation request. (5) From previous monthly analysis. (6) Supplied by individual in charge of construction. (7) Actual expenditures to date for the project, from accounting records. (8) Prepared from Cost & Progress sheets containing all cost information available to date. Use for major projects (over $100,000) and for other projects when necessary. (9) From original appropriation request. (10) Appropriation amount plus all supplements approved to date. (11) The difference between "Expected Total Cost Re-estimate" from Cost & Progress sheet and the "Appropriation with Supplements". For minor projects, show over-runs only when actual expenditures exceed appropriation. Percentages are to be based on appropriated amount plus approved supplements. (12) The difference between "Expected Total Cost Re-estimate" from Cost & Progress sheet and the "Appropriation with Supplements". For minor projects, show under-runs only at project completion. Percentages are to be based on appropriated amount plus approved supplements. (13) Indicate dates when projects and major divisions of projects are completed. Show status of supplement preparation, if required. Indicate projects to be dropped, curtailed or enlarged. Indicate principal progress and reasons for major changes since preceeding report. Comments are prepared by accounting representative, with the help of the individuals in charge of design and construction.

Table VII COST & PROGRESS SHEET FOR MAJOR APPROPRIATIONS

Division Chemical
Location Chicago
Month Ending 4 30 60

Approp. No. (1)	Approp. Title (2)	% Completion: Detail Design (3)	Req. (4)	Purch. (5)	Field Labor (6)	Material: Charged to Project (7)	Committed (8)	Req'd. to Complete (9)	Expected Total Cost (10)	Approp. w/Supp. (11)	Labor: Charged to Project (12)	Accrued (13)	Req'd. to Complete (14)	Expected Total Cost (15)	Approp. w/Supp. (16)	Total: Expected Total Cost (17)	Approp. w/Supp. (18)
06-41-4120	50 T/D Kiln for new ores	98	98	94	50	380,000	4,000	25,000	409,000	300,000	64,000	11,000	75,000	150,000	140,000	559,000	440,000

(1) From appropriation. (2) From appropriation, but abbreviated to a few words. For very large projects, list major sections also. (3) Percentage that developed detailed-design man-hours are of expected total (by design engineer). (4) Percentage that dollar value of requisitions sent to purchasing is of expected total (by design engineer). (5) Percentage that value of filled requisitions is of the expected total requisition value. (Unfilled requisition value by purchasing, Balance by design engineer). (6) Must check with labor required-to-complete and expected-total (by individual in charge of construction), (7) Material and fees invoiced and paid for, plus stores issued and freight paid (by accounting and stores). (8) Unpaid-for material on order. Stores material billed to field storeroom but not issued. Estimated freight and escalation, if of significant size. Earned fees not paid (by accounting and stores). (9) Includes material requisitioned but not bought (by purchasing), requisitions not yet sent to purchasing (by design engineer), stores bills not yet issued to the storeroom (by design engineer) and fees expected but not yet earned (by accounting). (10) Total of three preceeding columns. In early project stages, may be based in part on appropriation estimate. (11) Includes only approved supplements. (12) Company or contractor field labor performed and paid for (by accounting). (13) Company or contractor field labor performed but not paid for. Estimated by accounting, aided by individual in charge of construction. (14) Labor required to complete the project but not yet performed. Includes labor contracted for but not yet performed (by individual in charge of construction). (15) Total three preceeding columns. In early project stages, may have to be based in part on appropriation estimate. (16) Includes only approved supplements. (17) Total of expected totals for material and labor. (18) Includes only approved supplements.

Table VIII CAPITAL PERFORMANCE REPORT

Date Dec. 15, 1960 | Appropriation Number 06 | 41 | 4120

Division, Department or Subsidiary Chemical | Location Chicago | Plant Ore Roasting

Descriptive Title 50 Tons/Day Kiln for New Ores

Gross Investment	Appropriated + "Purpose" Supp.	Actual	Over-run	Under-run
Direct Capital Investment	$320,000	$418,000	$98,000	-
Supporting Utilities & Gen. Facilities	66,000	66,000	-	-
Transfer of Existing Capital Items	50,000	50,000	-	-
Operating Expense	20,000	45,000	25,000	-
Forced Retirements	95,000	95,000	-	-
Less: Tax Credit @ 52 % of $65,000	(34,000)	(47,000)	-	13,000
Working Capital	35,000	* 44,000	9,000	-
Other Items Know-how purchase	50,000	50,000	-	-
Sub-total	$ 602,000	$ 721,000	$ 132,000	$ 13,000
Reserve	120,000	- 0 -	-	-
Total	$ 722,000	$ 721,000	$ 132,000	$ 13,000
Net Change	-	-	$ -	$ 1,000
% Change	-	-	-	Negligible

Capital Performance Data

Appropriation App'v'd.	8/6/59	Supplemented	6/15/60	Closed	11/3/60
Detail Eng., Man-hr.	11,800	Started	8/10/59	Complete (98%)	6/1/60
Construction Man-hr.	25,206	Started	4/ 1/60	Complete (98%)	10/5/60
Production, Sched.	8/6/60	Initial	10/10/60	Commercial (75%)	11/1/60

Summary Comments (expand on attached sheets if necessary):

Process changes based on pilot-kiln tests used up all of the allowed reserve and were principally responsible for extending project completion by two months.

Operating start-up expense was substantially larger than expected.

Prepared B. L. C. | Checked R. J. B. | Approved B. B. C.

*Working capital should be re-estimated, based on data available to date. Attach complete report, by sub-account, of actual material and labor costs, engineering man-hours and field man-hours. This report not required for projects under $250,000.

Appropriation estimate figures include changes due to approved "purpose" revisions only. Otherwise, they are the figures on which original approval of the project was based. Interpolation is necessary to get values at actual production levels, based on the three levels computed in the estimate.

Actual figures are from operating records, but are computed on the same principles used in preparing the estimate. All costs, for example, are incremental ones.

The "Using Estimated Value" column is a recomputation of the return, using actual figures for all items except the single item in question. The estimated value is used for this. The return computed in this way indicates influence of the variance of this single item on project return.

Preparing actual figures for comparison with forecast figures is usually difficult. Data must be based on project economics considered in exactly the same way as when preparing the estimates. This seldom conforms precisely to the viewpoint used in preparing normal operating reports for project control. And arithmetic for comparisons is quite tedious. In fact, it may not be attempted unless project economics are programmed for an electronic computer.

In the "comment" space, notations should be made with the objective of pointing up areas where improvements seem possible in both project operations and in future estimating of profitability.

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His report is based on over twenty years in managing technical staff services for major chemical and metals companies in the United States.

Mr. Hackney is an author and lecturer in his chosen fields. Publications include "Capital Cost Estimating", "Estimate Production Costs" and "Scheduling of Process Plants" for Chem. Eng. *plus other articles for* Power, Cost Eng. Quarterly, Pet. Refiner, Construction Methods, *and the* Proceedings of ASCE. *He is one of the founders of the Montreal chapter of AACE.*

ACKNOWLEDGMENTS

Since this presentation has been built on an experience of many years in various phases of appropriation work, it is impossible to acknowledge all of the individuals who have directly or indirectly contributed

to its preparation. Special acknowledgment is due, however, to Roy Glauz, Development Engineer; E. J. Isackila, Cost Engineer; S. Perkins, Research Engineer; and Ray Armor, Controller, all of Diamond Alkali Co. and to E. A. Vaughn, Manager of Fixed Asset Accounting for the Aluminum Co. of America.

Table IX OPERATING PERFORMANCE REPORT

Date June 1, 1962 | Appropriation Number 06 | 41 | 4120

Division, Dept. or Subs. Chemical | Location Chicago | Plant Ore Roasting

Title 50 Tons/Day Kiln for New Ores

Values for Best Month to Date	Appropriation Estimate*	Actual	Using Estimated Value** % Return	Using Estimated Value** Changes from Act.
Production, month of April, 1962	-		-	-
Raw materials & fuel	$ 67,780	$ 91,100	45.5	-18.8
Utilities	1,600	1,700	26.7	0
Labor	13,560	27,300	37.8	-11.1
Supplies & Misc.	4,960	5,100	26.7	0
Fixed Costs	8,410	16,100	33.0	- 6.3
Loading, Packing & Shipping	1,860	2,100	26.7	0
Manufacturing Cost	98,170	143,400	62.9	-36.2
Sales Value of Production	150,600	201,000	-13.4	+40.1
Distribution Cost of Production	0	12,000	36.5	- 9.8
Gross Profit	52,430	45,600		-
Administration, Sales & General	11,900	12,000	26.7	0
Net Profit	40,530	33,600	-	-
Income Tax	21,100	17,500	-	-
Net Profit after I.T.	19,430	16,100	-	-
Annualized Profit	233,000	193,000	-	-
Gross Investment	$ 722,000	$ 721,000	26.7	0
Return	32.3 %	26.7 %	-	-

Interest Rate of Return	Appropriation	Current Re-estimate	Cumulative Cash Flow App'n.	Cumulative Cash Flow Re-estimate
Target Rate	14.0 %	-	1) $148,000	$ 5,112
Forecast Rate	25.2 %	19.1 %	2) 348,000	200,000
Forecast Life	10 yr.	10 yr.	3) 595,000	450,000
			4) 1,178,000	810,000
			5) 2,291,000	1,750,000

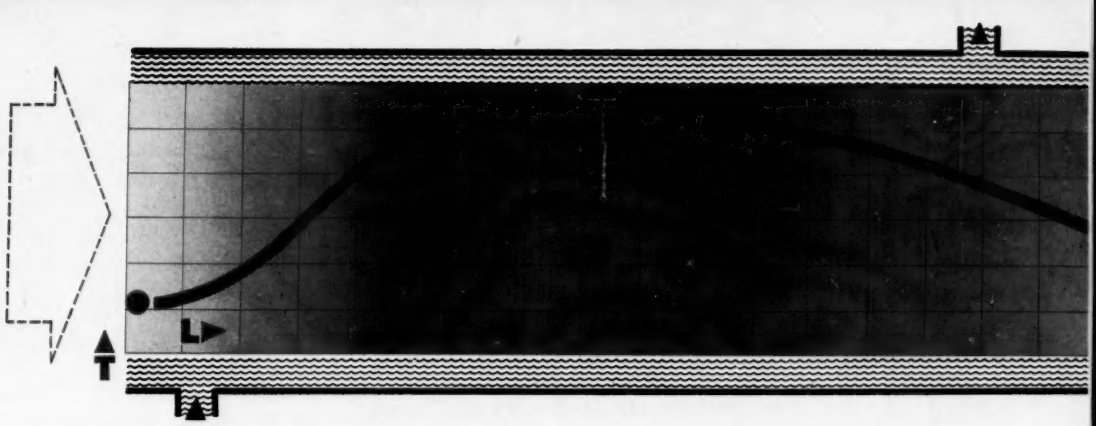
Summary Comments:

Inflation substantially increased sales prices, but the gain was wiped out by increases in manufacturing cost and the necessity for incurring distribution costs to obtain sales.

Profit still well above target estimate, although not as attractive as anticipated.

Prepared R. L. Beam | Checked B. B. | Approved R. B. L.

*Appropriation Estimate is from Appropriation plus Purpose changes, interpolated to actual production.
**All items taken at actual value except the one being tested, for which estimated value is used. This report not required for projects under $250,000.



A slight change in tubular-reactor conditions may cause uncontrolled temperature rise in exothermic reactions. Here's how to prevent it ahead of time.

Designing Temperature-Stable Reactors

PETER HARRIOTT,
Associate Professor, Cornell University

In plant equipment, it's often difficult to carry out chemical reactions with the same degree of temperature control that is possible in small lab units. For exothermic reactions, a reactor operating satisfactorily at a certain temperature may jump to a much higher temperature after just a slight change in feed concentration or jacket temperature.

This tendency to instability occurs because of the exponential increase in reaction rate with increasing temperature, compared with the linear increase in heat that is transferred with increasing temperature difference. Where the conversion is normally low—as in the first part of a plug-flow reactor, or in the first of a series of stirred-tank reactors—the danger of runaway temperatures is greatest.

The problem, then, is to design a reactor, plus its control system, for nearly isothermal operation and with adequate safeguards against runaway temperature. In design, the heat-transfer rate may become as important or more important than the kinetics in determining reactor dimensions. To prevent instability, calculation of the heat-transfer area must be done more carefully than in sizing an ordinary heat exchanger. But the exact behavior of reactors is described by rather complex equations. The aim here is to give a relatively simple method for predicting the approximate behavior of reactors.

We shall discuss in this article the case of a rapid exothermic reaction in a homogeneous pipeline reactor. In a future article, we shall consider the same reaction case for a packed-tube reactor and for a stirred-tank reactor, operating at only moderate conversion.

For endothermic or adiabatic reactions, the temperature stability problem does not exist. And yet another type of instability occurs with high-temperature converters: the possibility that reactor temperature will suddenly drop to a much lower value, as when a flame is blown out. This case is not covered, in this article though similar reasoning and analysis would apply.

Stability in Tubular Reactors

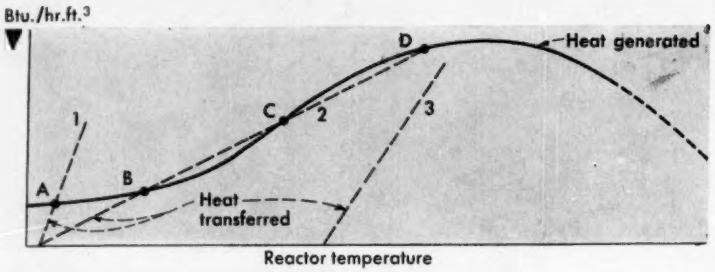
When an exothermic reaction is carried out in a jacketed pipe, a slight rise in temperature at some point in the reactor may increase the rate of heat generation more than the rate of heat removal, leading to a rapid rise in temperature at that point. This is more likely to happen in large pipes than in small. Reactor volume, in which heat is generated, is proportional to the square of the diameter, but heat-transfer surface is proportional only to the diameter.

The graph temperature vs. reactor length shown above is typical of the temperature profile for a tubular reactor. Whether the feed enters at a temperature above or below the jacket temperature is unimportant. If the feed temperature is much lower than that of the jacket, the first section of the reactor is considered a preheater.

As reactor temperature rises, the rate of reaction increases and rate of heat removal also increases. Reactor temperature is highest where the local rate of heat removal equals the rate of heat generation. When reaction rate decreases with increasing conversion, reactor temperature decreases, approaching the jacket temperature if the reactor operates near 100% conversion. When reaction rate is independent of concentration (zero-order), the reactor temperature stays at maximum value until the reaction is complete.

Reactor stability is examined by making a heat balance to determine the maximum temperature in the reactor temperature profile. Complete kinetic data are not needed for a preliminary analysis. However, overall heat-transfer coefficient, heat of reaction and rate

Graph is first step to find steady-state temperature.—Fig. 1



of reaction at various temperatures must be known.

With the exception of autocatalytic reactions and reactions with an induction period, the important reaction rate is the maximum rate for a given temperature—usually the initial rate. This maximum rate can be used to set safe operating conditions, because the danger of runaway temperature is greatest near the reactor entrance, where conversion is low. The error in using this maximum rate makes the design conservative. A better, yet conservative, method is to use the rate that would exist at each temperature if the reactor were operated adiabatically. Fairly accurate if the maximum temperature is not much greater than jacket temperature, this method partially allows for the conversion that takes place up to the point of maximum temperature.

A step-by-step calculation of the temperature profile is required for greater accuracy. This might be justified for an exact design, after preliminary conditions have been selected, using the shorter method.

Find Steady-State Temperature

A heat balance for a differential volume of reactor at the point of maximum reactor temperature shows that rates of heat generation and transfer to jacket are equal when the reactor temperature is constant. This steady-state temperature is found most easily by plotting both heat release and heat-transfer rates against the reactor temperature, as shown in Fig. 1.

Slope of the heat-generated curve increases initially because of the exponential effect of temperature on reaction rate. Eventually, however, it decreases and approaches zero as the adiabatic reaction temperature is approached. Note that the heat-transfer curves are linear, which assumes a constant heat-transfer coefficient and constant jacket temperature. Slope of the heat-transfer curves is proportional to the transfer area multiplied by the heat-transfer coefficient. Their intercept on the temperature axis is the jacket temperature.

In Fig. 1, three different cases of heat transfer are shown. Curve 1 intersects the heat-generated curve only once—at point *A* the maximum reactor temperature. This operating point is stable because a slight increase in reactor temperature leads to more heat removed than generated, which tends to return the temperature to normal. A decrease in temperature is also self-correcting.

Curve 2 intersects the heat-generated curve at three points, the lowest of which (*B*) is a stable operating point. Point *C*, however, is unstable, even though the heat-balance equation is still satisfied. Above *C*, a slight increase in temperature would release more heat than could be removed. This, of course, would push the temperature still higher, in a rapid ascent to point *D*. In the other direction, a slight decrease in temperature from *C* would rapidly send the temperature down to *B*.

Points *B* and *D* (and *A*, as well) are stable because the heat-transfer curve is steeper than the heat-generation curve at their intersection. Although point *D* is stable, it repreesnts nearly complete conversion at a high temperature. Since the numerical examples that follow are concerned with low or moderate conversion, point *D* is of little interest here except to predict what temperature would be reached if the reaction ran out of control.

If points *B* and *C* were close together, the reactor would be potentially unstable. A momentary rise in jacket temperature, represented by displacement, to the right, of the heat-transfer curve, might raise the reactor temperature from *B* to *C*. This would lead to much higher temperatures, even though the normal jacket temperature were restored. An inverse measure of reactor stability in this case is the temperature difference between *B* and *C*. This difference should be greater than reactor temperature fluctuations that might result from fluctuations or temporary upsets in coolant flow or temperature, feed concentration or feed rate.

Heat-transfer curve 3 doesn't intersect the heat-generated curve in the low or moderate temperature region, so temperature and conversion is very high in the first part of the reactor. Lower jacket temperature, or higher heat-transfer coefficient or area, is needed to make this case similar to the second.

Selection of a reasonable jacket temperature is one of the keys to sound reactor design. The lowest possible temperature might at first glance seem best, but the reaction might never reach the desired temperature with too cool a jacket. Use of the lowest possible jacket temperature would also leave no margin for control. To allow for control of upsets, it should be possible to double the normal rate of heat removal approximately, by increasing the driving force, the coefficient, or by using a combination of both of these methods.

Case 1: Inherent reactor stability

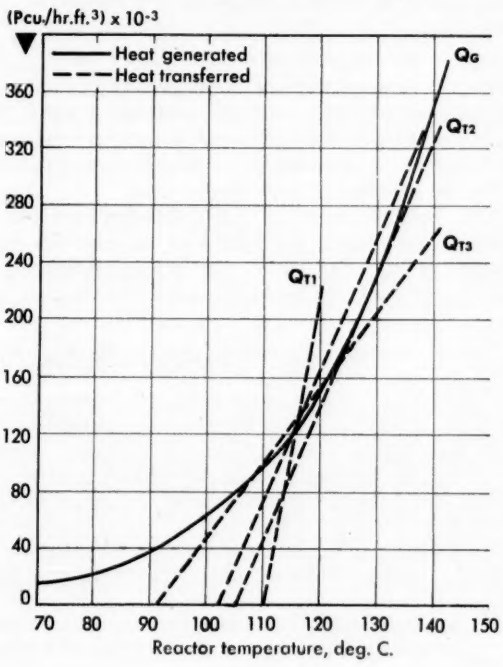
The following example shows how reactor diameter and jacket temperature can be selected to give stability at a given reactor temperature.[1]

Feed enters the tubular reactor at 100 C. and a flow rate of 30 cu. ft./hr. Its initial concentration is 0.2 lb. mol/cu. ft., and the desired reaction temperature range is from 110-120 C., above which excessive byproducts are formed. Heat of reaction is 25,000 Btu./lb. mol, and heat capacity is 20 (pound centigrade units)/(cu. ft.)(°C.). A first-order reaction is assumed in this example.

Temp., °C.	Reaction Rate Constant, 1/Hr.	Conversion for Adiabatic Reaction, Starting at 100 C.	Reaction Rate × Heat of Reaction, (Pcu.)/(Cu. Ft.)(Hr.)
100	12	0	60,000
110	20	4	96,000
120	32	8	147,000
130	54	12	278,000
140	88	16	353,000
150	132	20	528,000
350	...	100	.....

Heat-transfer curves for each of three possible reactor sizes, indicated on the graph of Fig. 2 by Q_{T1}, etc., are calculated from the following data. Values for U are just approximated to allow for decreased velocity in larger pipes.

Determine maximum reactor temperature (no control).—Fig. 2



	1-In.	2-In.	3-In.
A, sq. ft./cu. ft.	45.8	23.3	16.8
U,(Pcu.)/(hr.)(sq. ft.)(°C.)	500	400	300
UA, × 10^3	22.9	9.3	5.05

The heat transferred is determined by substituting values in the relationship,

$$Q_T = UA(T_R - T_j) \quad (1)$$

where T_R is the reactor temperature, and T_j is the jacket temperature.

In a 1-in. pipe, the reaction can be carried out with a jacket temperature of 110 C. Maximum reactor temperature is 115 C., and if the jacket temperature rises to 115 C., maximum reactor temperature goes to 122 C.; the reactor remains stable. With a simple system controlling jacket temperature, it should be possible to keep the reactor hot spot within 1 deg. C. of the desired temperature. If jacket temperature fluctuations are kept less than 5 deg. C., the reactor is stable.

With a 2-in. reactor, jacket temperature must be 102 C. to keep reactor temperature at or below 115 C. This graph shows an unstable point at 139 C., which seems far enough away to be safe. If, however, jacket temperature rises to 105 C. (shown by right-hand parallel line for Q_{T2}), the rate of heat transfer equals the rate of heat release only at 125 C. This is an unstable point because the heat-release curve is steeper than the heat-removal curve above the point of tangency.

To prevent runaway reactor temperatures, closer control of jacket temperature is needed than for the 1-in. reactor. Jacket temperature must be held to 102 C. ±2 C. to keep the reactor hot spot between 110-120 C. This can probably be done with a controller that adjusts relative flows of hot and cold fluid to the jacket, or adjusts jacket pressure if a boiling coolant it used. Set point of this controller can be adjusted manually, or by a primary instrument controlling reactor temperature (cascade control). The 2-in. reactor can be operated safely at 115 C., but it is inherently stable only for small temperature fluctuations.

The 3-in. reactor tends not to operate in the desired range. With a jacket temperature of 91 C., the stable point is 108 C.; when 92 C., unstable equilibrium is reached at 115 C. It wouldn't be safe to preset jacket temperature or to use a jacket-temperature controller only, but cascade control might permit operation at 115 C. Considering the uncertainty of position of the hot spot, however, it would be safer to use a reactor with some stability at constant jacket temperature.

Points of borderline stability correspond to a temperature drop from reactor to jacket of about 20 deg. C.—1.5 times the temperature rise needed to double the reaction rate. This is another way of stating the general rule that the fractional rise in heat transfer per degree must exceed the fractional rise in heat generated per degree, if the reactor is to be stable. In these cases, the reaction rate increases by 5%/deg. C., and doubles in 13.5 deg. C.; the critical temperature drop is 1/0.05 or 20 deg. C. If the rate increases 8%/deg. C. (doubling in 9 deg. C.), the critical temperature drop is about 13 deg. C.

How controller gain affects reactor stability.

Fig. 3

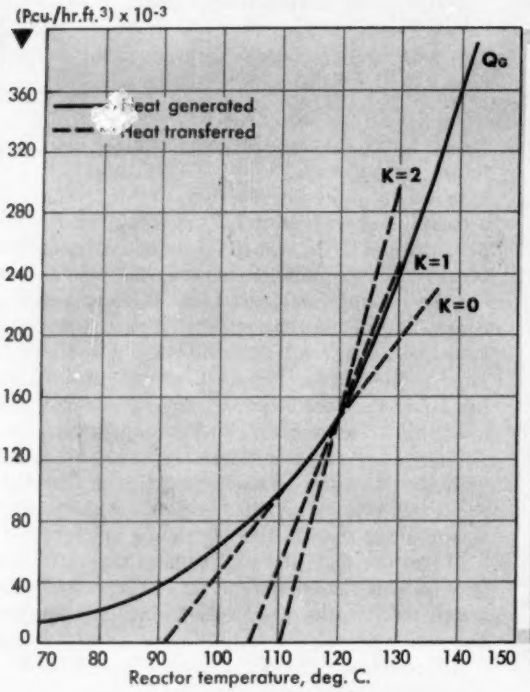
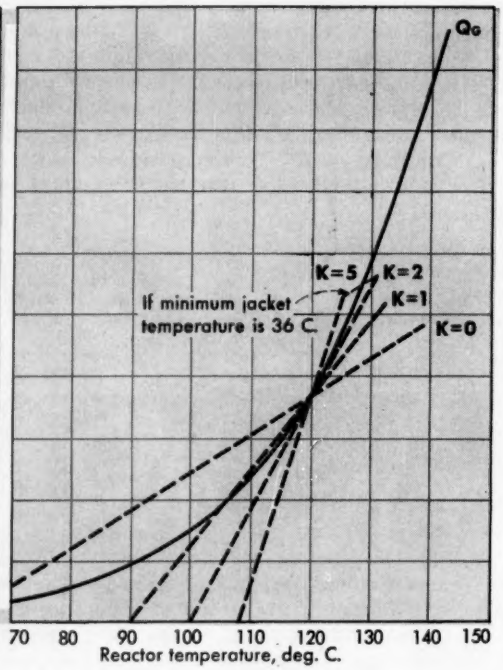


Fig. 4



Case 2: Adding proportional control

With a control system, a reactor can be operated at what would otherwise be an unstable point. The effect of the control system is to make the heat-transfer curve steeper than the heat-generated curve, either by decreasing jacket temperature or by increasing coolant flow rate as reactor temperature rises. Adjusting the backet temperature is probably the more effective control scheme, and it is also easier to analyze.

For control of jacket temperature, the control-system "gain," K_c, that a proportional controller provides is the steady-state change in jacket temperature for a unit change in reactor temperature:

$$K_c = -\Delta T_j/\Delta T_R$$

Whether there is one controller or two, as in cascade control, the definition of gain is the same. The over-all gain of the control loop is the control-system gain (sensor, controller, valve and jacket) multiplied by the gain of the reactor.

If we wish to control the previously described 3-in. tubular reactor at 120 C. (an unstable point as shown by the no-control $K_c = 0$ curve of Fig. 3), then it's necessary to alter the previous analysis. The heat-transfer curve without control is:

$$Q_{T3} = 5{,}050(T_R - T_j)$$

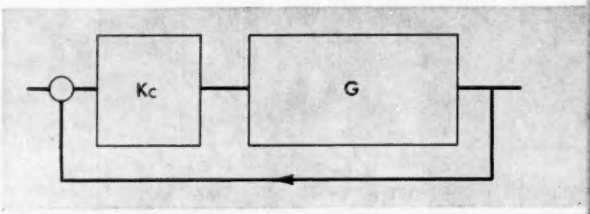
But with control, $T_j = (T_j)_o - K_c\,(T_R - T_{R_o})$, where the subscript o means normal values. Substituting this into the above equation, with known numerical values, gives a steady-state expression of how proportional control modifies the heat-transfer curve:

$$Q_{T3} = 5{,}050\,[T_R(K_c + 1) - 120K_c - 91]$$

Thus, the slope of the heat-transfer curve is increased by a factor $(K_c + 1)$ with proportional control. The minimum gain to make the heat-transfer curve steeper than the heat-generated curve is about 1. If possible, a higher gain would probably be used.

The modified curves of Fig. 3 still don't account for dynamic behavior of the reactor or the control system. Values of heat flux apply only if the control system acts rapidly enough to keep jacket temperature pro-

Here's basic block diagram . . .



Feedback control loop is shown in simple diagram giving relationship of controller (K_c) and reactor.

portional to reactor temperature. If system "lags" other than that of the reactor are significant, dynamic analysis would have to supplement the steady-state analysis.

If the heat-transfer coefficient were only about half as great as before,

$$Q_{T3} = 2{,}500(T_R - T_j)$$

With no control, T_j is fixed, and at 120 C., $Q_{T3} = 147{,}000$. Therefore, $T_R - T_{j_o} = 59$, and $T_{j_o} = 61$.

$$T_j = 61 - K_c(T_R - 120)$$

With proportional control, then,

$$Q_{T3} = 2{,}500\,[(K_c + 1)T_R - 120\,K_c - 61]$$

This equation is plotted in Fig. 4 for several values of K_c. Minimum gain for control is about 3. Limits of jacket temperature should be checked, however, before assuming that any reactor can be made stable by using high-enough gain. In Fig. 4, the heat-transfer curve for $K_c = 5$ is much steeper than the heat-generated curve, but it changes to a lesser slope when the control valve is wide open.

If 36 C. were the minimum jacket temperature, the line for $K_c = 5$ would change to a slope one sixth as great, starting at 125 C. This would mean an unstable intersection at about 128 C. Any upset that permitted an 8 deg. C. rise in temperature would lead to runaway temperatures regardless of controller action. Whether 8 deg. C. is a sufficient margin of safety would usually be determined by common sense.

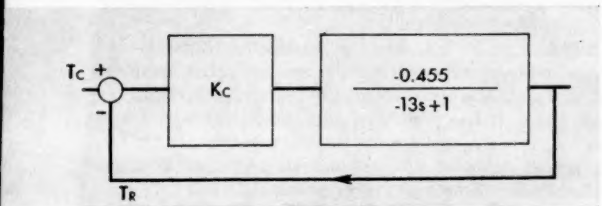
Dynamic Analysis of Reactor Control

Increasing the controller gain is desirable for more-rapid control action, but as in all feedback systems, there is a maximum gain above which unstable oscillations result. The optimum gain is generally about half the maximum. If the reactor is operating at a stable point, the maximum gain can be found from a frequency-response plot (Bode diagram) for the open-loop system. By using a linear approximation for the reaction-rate curve, the differential equation for the tubular reactor is:

$$(\rho c)\frac{dT}{d\theta} = \left(\frac{dQ}{dT}\right)T - UA\,(T - T_j)$$

where the first term is heat capacity, dQ/dT is slope at normal operating temperature, T is normal reactor temperature and T_j is normal jacket temperature.

. . . with reactor response.—Fig. 5



Reactor response is represented by a simple linear equation whose solution gives time constants shown.

$$\left(\frac{\rho\,c}{UA - \frac{dQ}{dT}}\right)\frac{dT}{d\theta} + T = \frac{UA\,T_j}{UA - \frac{dQ}{dT}}$$

or

$$T_r\frac{dT}{d\theta} + T = K_r T_j$$

This equation can be transformed, with an operator, to

$$T/T_j = K_r/(T_r s + 1)$$

As long as UA exceeds dQ/dT, the dynamic response of the reactor can be represented on a Bode plot and combined with the responses of other components in the control loop to get the maximum gain. Note that the effective time constant of the reactor, T_r, becomes very large as dQ/dT approaches UA, which means that the reactor comes to steady state very slowly.

In the more-difficult case, where $UA < dQ/dT$, control is possible as long as the reactor itself contributes most of the lag, despite the positive root introduced by a negative T_r. Returning to the case of Fig. 4, for example, $dQ/dT = 8{,}000$ and $UA = 2{,}500$. The constants, then, are

$$K_r = 2{,}500/(2{,}500\text{–}8{,}000) = -0.455$$
$$T_r = [20/(2{,}500\text{–}8{,}000)]\,(3{,}600) = -13\text{ sec.}$$

If other lags can be neglected, the block diagram is Fig. 5 (left).

For the closed loop:

$$T/T_c = G/(1 + G) = [K/(K + 1)]\{[-13/(K + 1)]\,s + 1\}^{-}$$

where $K = -0.455K_c$, the over-all gain.

If $K > 1/-0.455$, then $K < -1$; the terms $K(K + 1)$ and $-13/(K + 1)$ are both positive, and the system acts as a conventional first-order system. That the absolute value of the over-all gain must be greater than 1.0 is another way of stating the criterion for temperature stability of inherently unstable reactors such as these.

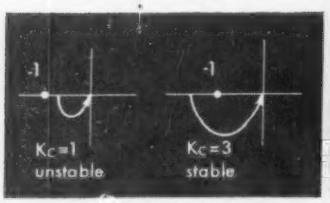
Using the Nyquist Diagram

Since the effective time constant of a tubular reactor is small, other lags usually have to be considered. The polar Nyquist diagram[2] is a good way to demonstrate effects of other lags and of controller gain on reactor stability. The diagram for the reactor alone is obtained by substituting jw for s in the transfer function.

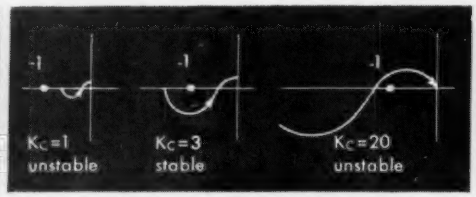
The polar plot starts at 180° lag and goes toward 90° lag, the mirror image of the plot for an ordinary first-order lag. The system is unstable with a low gain; there is one positive denominator root and no counterclockwise encirclement of the −1 point. The block diagram, Fig. 5 (right), is the system under consideration, and Nyquist plots for it are shown in Fig. 6 (left).

Addition of two small lags to the system increases the maximum phase lag to 270°. The minimum controller gain is the same as before (that required for an over-all steady-state gain of 1.0), but there is also a maximum controller gain that gives an over-all gain of 1.0 at the higher frequency corresponding to 180°

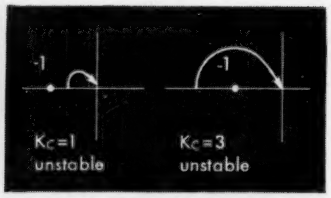
Nyquist Diagrams Check Stability—Fig. 6



Case 2—Using proportional control. Reactor alone, with no lags.



Adding two small lags to the system gives the plots shown above.



With two large lags added, stable operation is not obtained.

phase lag. Process gain, G, of Fig. 5 (right) is now multiplied by $(1/1.3s + 1)^3$. Nyquist plots appear in Fig. 6 (center).

If two large lags are added to the original system, so that G is multiplied by $(1/13s + 1)^3$, the phase lag is always greater than 180°, and an over-all gain greater than 1 leads to a clockwise encirclement of the −1 point on the Nyquist plot. There is no controller gain that makes the system stable. The other lags have to be reduced—perhaps by cascade controls—or the time constant of the reactor increased, to permit stable operation. Nyquist plots are shown in Fig. 6 (right).

Other Modes of Control

All this discussion has dealt with temperature control of the reactor based on temperature at or near the hot spot, or based on control of jacket temperature. In some cases, a controller can be used to adjust output concentration, by varying the proportion of reagents, the flow rate of the jacket temperature. Even with an ideal instrument to measure exit concentration without delay, these schemes are all handicapped by the deadtime lag which exists in the tubular reactor.

This lag is generally large enough to contribute 180° phase lag before appreciable damping occurs in other parts of the control loop. The maximum over-all gain is therefore about 1, which makes it difficult or impossible to control composition by changing jacket temperature and still avoid runaway temperatures. If stability is a problem, it would be better to have a separate temperature controller and use a composition controller to adjust reactant flow rates.

We have not allowed for different orders of reaction or different feed temperatures. If a reactor is barely unstable with a feed temperature equal to the jacket temperature, it probably would be stable with a 10 deg. C. lower feed temperature. The effects of feed temperature and reaction kinetics can be treated by using the solutions developed by Barkelew[11] for temperature profiles in packed beds. The methods of determining reactor stability outlined here are conservative, yet probably accurate enough for most purposes. When more work is done on the dynamic behavior of reactors in a control loop that has other important lags, a simple model of the reactor may have to be used for solutions.

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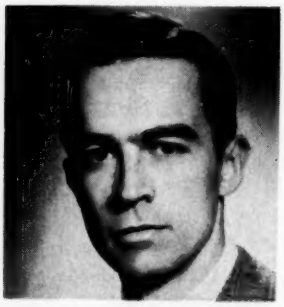
Meet the Author



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Prof. Harriott has published numerous papers and is a member of the Process Control Subcommittee of AIChE.

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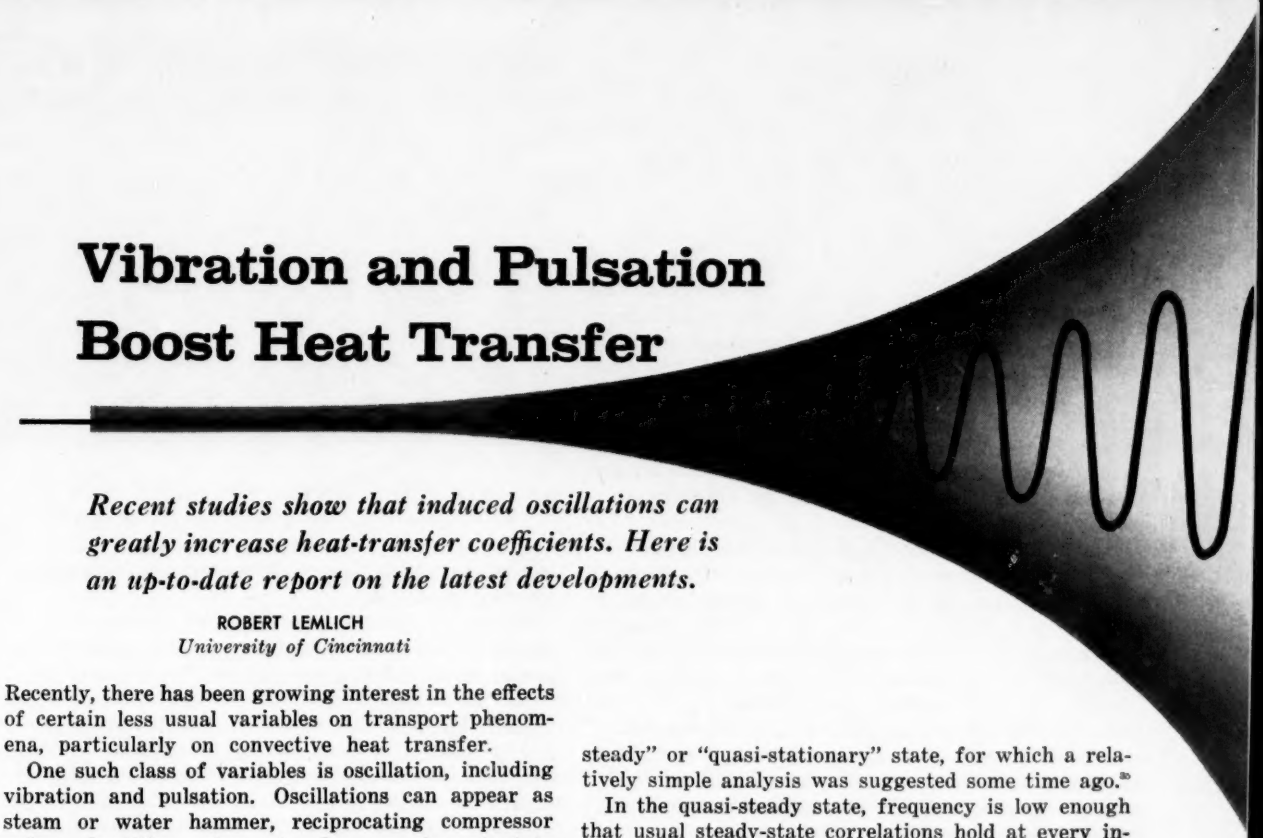
Vibration and Pulsation Boost Heat Transfer



Recent studies show that induced oscillations can greatly increase heat-transfer coefficients. Here is an up-to-date report on the latest developments.

ROBERT LEMLICH
University of Cincinnati

Recently, there has been growing interest in the effects of certain less usual variables on transport phenomena, particularly on convective heat transfer.

One such class of variables is oscillation, including vibration and pulsation. Oscillations can appear as steam or water hammer, reciprocating compressor pulses, throttling noises, etc. Or, more important to this discussion, oscillatory motion can be imparted deliberately, either to the medium or to the surface.

The terms "vibration" and "pulsation" are often used interchangeably, although the latter is sometimes reserved for periodicity as it appears in the flow of a liquid. Variables in oscillation include frequency, amplitude and manner of application.

This last variable refers to the direction of oscillation; that is, whether the oscillation is longitudinal or transverse relative to the heat-transfer surface or direction of flow. It also refers to whether the oscillation is applied to the fluid (as with sound waves) or to the surface (as with a vibrator attachment). Although similar, these two are not the same.

For the first case, any attenuation of the boundary layer comes from without; for the second, from within. Some differences between the two cases have been discussed.[12] Under certain circumstances, however, these differences are quite small.

In terms of quantitative results among the various studies, disagreement has been the rule rather than the exception. This is not surprising, however, in view of the many possible combinations of oscillatory variables, to say nothing of their interaction with all the usual convective variables such as velocity, fluid properties, etc. As a result, some investigators report great increases in heat-transfer coefficient from oscillation, and others little, none or even a decrease!

Predict Behavior for Quasi-Steady State

With one important exception, suitably general theory and broad independently verified correlations are still lacking. This exception is the so-called "quasi-steady" or "quasi-stationary" state, for which a relatively simple analysis was suggested some time ago.[20]

In the quasi-steady state, frequency is low enough that usual steady-state correlations hold at every instant. Integration with respect to time is carried out over a complete cycle, to find average coefficient.

To illustrate, consider the case of a forced convective heat exchanger in which the axial flow of a fluid with constant physical properties is periodically decreased or interrupted but not reversed. By conservation of mass, the average velocity V_m over a cycle period of $1/F$ is given by

$$V_m = F \int_0^{1/F} V d\tau \tag{1}$$

Within reasonable limits of flow rate,

$$h = KV^n \tag{2}$$

and

$$h' = KV_m^n \tag{3}$$

where h' is the heat-transfer coefficient that would prevail at the steady-state velocity, that is, without pulsation. Now, if the change in driving force Δt throughout a cycle is small, then by heat balance over a cycle period,

$$Q = \frac{h_m A \Delta t}{F} = A \Delta t \int_0^{1/F} h d\tau \tag{4}$$

Dividing Eq. (4) by Eq. (3), and then substituting Eqs. (1) and (2), yields

$$\frac{h_m}{h'} = \frac{F^{1-n} \int_0^{1/F} V^n d\tau}{\left(\int_0^{1/F} V d\tau \right)^n} \tag{5}$$

Now,

$$\theta = 2\pi F \tau \tag{6}$$

so that

$$d\theta = 2\pi F d\tau \tag{7}$$

Substituting Eq. (7) in Eq. (5) and altering limits,

$$\frac{h_m}{h'} = \frac{(2\pi)^{n-1} \int_0^{2\pi} V^n \, d\theta}{\left(\int_0^{2\pi} V \, d\theta \right)^n} \qquad (8)$$

The velocity waveform equation, $V = \phi(\theta)$, can then be substituted in Eq. (8) and the integration carried out (by approximate methods if necessary) to give the coefficient ratio h_m/h'. For a sine wave, the equation $V = V_m + B \sin \theta$ would be used. For a rectangular wave, each integral in Eq. (8) would be broken into two parts, one for the level trough of the wave and the other for the level crest.[41, 55] Note that for any waveform Eq. (8) is independent of frequency.

For n less than unity, which is almost always the case, Eq. (8) will predict a decrease in coefficient with pulsation. When n is greater than unity, however, which sometimes occurs in the transitional flow region, Eq. (8) will show an increase. For n equal to unity, there is no change. These statements are predicated on constancy of pertinent fluid properties. If these properties vary markedly, an increase in coefficient may be obtained even outside the transitional region.[40]

The frequency level above which a system is no longer quasi-steady has not been reliably established for the general case. The many different variables, together with the uncertain effects of harmonics, make such a prognostication difficult, and differing criteria have been offered.[9, 16, 43] As a rough guide, I suggest that for most systems the critical frequency will be within the subsonic frequency region, that is, well below 20 cycles/sec.

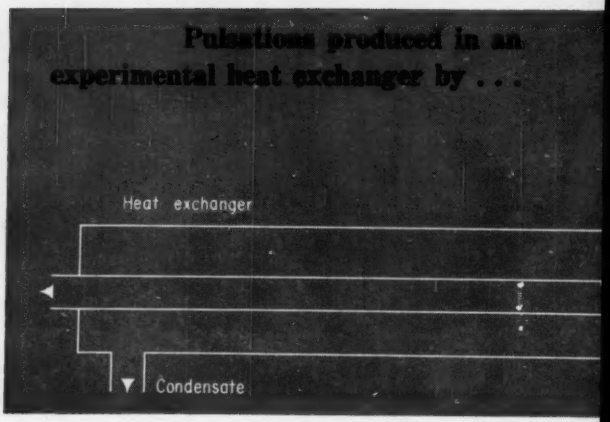
Consider the Nonsteady State

At frequencies above the critical, a system can be described as "nonsteady" in contrast with quasi-steady. With the displacement amplitude held fixed, raising the frequency above the critical level usually increases the heat-transfer coefficient. Each cycle of motion acts as a disturbance. Increasing the number of such disturbances per second tends to increase the total overall effect on the boundary layers involved. This is by no means a complete explanation, however.

Cases where the coefficient subsequently decreases with further elevation in frequency are not unknown. This inverse behavior has been attributed[52] to cyclic fluctuations in wall temperature. For constant wall temperature, such a decrease would not likely occur.

The coefficient generally increases with displacement amplitude for a fixed frequency above the critical level. At low amplitudes, this improvement is often too small to be detected but the coefficient rises at an increasing rate as the amplitude is raised.

At lower amplitudes, the usual forced or natural convective currents predominate. Not until amplitude is raised sufficiently do the disturbances produced become relatively significant—usually at an accelerating rate. In some cases, however, an upper limit to the particular mechanism may appear and decelerate this rate, giving the curve of coefficient vs. amplitude something of an S-shaped, or even peaked, appearance.



The relative effect of increasing the displacement amplitude at constant frequency generally equals or somewhat exceeds that of increasing the frequency at constant amplitude.

Above the critical frequency, the relative effect of oscillation at fixed frequency and fixed displacement amplitude is usually greater at low flow Reynolds numbers than at high, and for natural convection than for forced. The reason is similar to that presented above for the increasing slope as amplitude increases—when the disturbances produced by oscillation are relatively significant compared with those otherwise present, the coefficient of heat transfer is likely to increase.

A number of different specific mechanisms have been suggested for the nonsteady state. They are not all necessarily in conflict, however, because some of them are meant to apply to very differing systems.

Effects in Natural Convection

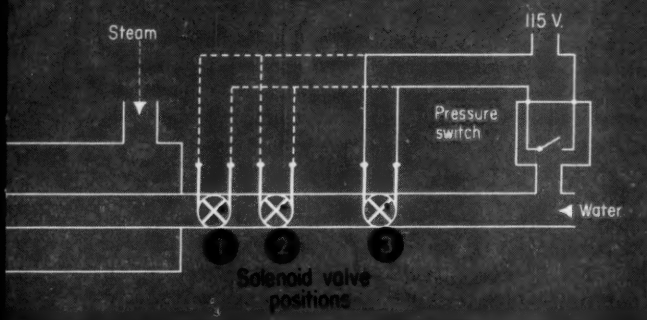
For sonic vibrations applied to natural convection, improvement in the heat-transfer coefficient has been credited[39] to additional currents of acoustical streaming. Such currents are produced, even under isothermal conditions,[48] when sound impinges on a solid body or a body vibrates in an otherwise calm fluid.

Acoustical streaming currents are basically of a d.c. nature and are superimposed on the a.c. motion that induces them. A special sort of coupling between streaming currents and natural convection currents, termed "thermo-acoustic transduction,"[27] has been suggested.[31] For small values of s/D (ratio of displacement amplitude to diameter), a criterion for the minimum effective amplitude ("critical amplitude") has been offered,[56] according to which, significant improvement in heat transfer occurs only when s exceeds the a.c. boundary layer thickness. This thickness equals $\sqrt{\mu/\rho\omega}$ where ω is the so-called "circular frequency" $2\pi F$. A criterion for "critical intensity" can thus be expressed by a kind of Reynolds number as shown by

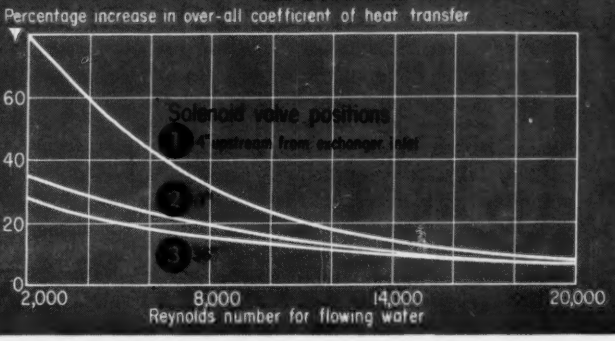
$$Re_p = \frac{s^2 \omega \rho}{\mu} = 1 \qquad (9)$$

For air at atmospheric conditions, the criterion has been expressed as Eq. (10), which predicts the "critical sound pressure-level" in decibels (referred to 0.0002 microbar) above which the effect of sound on the coefficient of heat transfer should be significant.

. . . pressure switch combined with solenoid valve cause varying improvement in . . .



. . . heat-transfer coefficient, depending on solenoid location.



$$S.P.L. = 136 + 10 \log_{10} (F/1{,}000) \quad (10)$$

Eq. (10) is supported by experiment.[12, 13, 58]

When considering heat transfer involving a surface vibrating in a fluid, care must be taken in extrapolating from the converse case where the body is stationary and the fluid vibrates. Despite certain similarities, the two situations are not quite the same. With sound, alteration of the convective boundary layer comes from without; with surface vibration, from within. Furthermore, with sound the displacement amplitude is usually relatively small, while with a vibrating body, such as a wire or granule, amplitude can easily exceed the diameter of the body.

For vibrating wires in natural convection, correlation of the fractional improvement in heat transfer in terms of a "stretched film" vibrational Reynolds number Re_s has been proposed.[27]* For a fixed Prandtl number, this suggests

$$\frac{h_m}{h'} = \phi (Re_s) \quad (11)$$

where $Re_s = (D + H)\, v_m \rho/\mu$. The inner length of the stretched film is $(D + H)$, where $H = 2s$ and is sometimes called the "double amplitude." Average velocity $v_m = 2HF$. Use of Re_s has been extended to the analogous mass-transfer case.[29]

Effects in Forced Convection

In forced convection, axial flow through a tube is a very important case. Oscillations of sufficient frequency and amplitude can substantially lower the critical flow Reynolds number[30] and steepen the velocity profile near the wall.[60] This amounts to increasing the level of turbulence and, by analogy of heat transfer to mass transfer, increasing the heat-transfer coefficient. The oscillations can be viewed as acting at least in part as a turbulence trigger.[29]

It has been proposed[31, 52] that appreciable improvement in coefficient occurs only when pulsation amplitude is large enough to allow a momentary reversal of flow during each cycle. For acoustical vibration, tuning the frequency to resonance so that standing waves are set up within the tube gives greater holdup of acoustical energy and larger amplitude in the tube. This resonant effect can be so marked that even modest detuning may stop all measurable improvement.

Pulsator Improves Forced Convective Transfer

Searching for a convenient, reliable and relatively inexpensive way to introduce pulsations in a heat exchanger, I have devised an electrical-hydraulic pulsator. In essence, it consists of a solenoid valve triggered by an adjustable pressure switch.

In tests carried out with the aid of some of my students, especially James C. Armour, the valve and switch were installed a short distance upstream in the water line of a ½-in. I.D., 3-ft.-long, copper, double-pipe, steam-to-water heat exchanger. Shown above is a simplified diagram of the apparatus. The solenoid valve was open when de-energized, allowing pressure in the water line to fall until the pressure switch closed its contacts, which in turn energized and closed the valve. The pressure then quickly rose until the switch opened, de-energizing and opening the valve, thus allowing the pressure to fall rapidly. The entire cycle then automatically repeated at the electrical-hydraulic resonant frequency of roughly 1.5 c.p.s.

These pulsations increased the over-all coefficient of heat transfer by as much as 80% (at a flow Reynolds number of 2,000) depending on the upstream location of the solenoid valve. The closer the valve to the exchanger inlet, the better, as shown by the graph.

These pulsation increased the over-all coefficient of ances caused by cavitation. When the solenoid valve closes quickly, inertia of the moving stream tries to pull the water apart, so to speak. In the stream, local pressures drop to or below the vapor pressure and bubbles form momentarily, chiefly at the heated wall, where their disturbing effect in the boundary layer is of greatest benefit. These bubbles collapse when the valve opens, only to form again during the next cycle.

Relocating the pulsator downstream from the exchanger so that cavitation does not take place in the exchanger produces a decrease in the rate of heat transfer, as might be expected from the nature of the quasi-steady state discussed earlier. Work along somewhat similar lines has been carried out in England.[8]

In our experiments, as a bonus, the vigorous pulsative action removed some fouling that built up in the exchanger during extended periods of shutdown. The pulsations did not appear to damage any of the parts.

Tests are now under way with shell-and-tube ex-

* A correction for Ref. (27) appears in *Ind. Eng. Chem.* **53**, 314 (1961).

changers and preliminary results are encouraging. Accordingly, I suggest consideration of the pulsator described above for industrial and other applications, particularly where its simple installation will boost the performance of an already existing exchanger.

The discussion to this point has touched only the more salient features of the subject. A more comprehensive presentation of the work in this field appears in the table. This table and the list of references should allow quick scanning of much of the field.

In addition to the experimental work summarized in the table, there exists a number of papers, chiefly theoretical, dealing largely with the dissipation of aerodynamic or compressional heating under oscillatory conditions. (Some of these are cited in Refs. 10, 14, 30, 36, 38, 42, 45, 46, 47, 48, 67.)

There is also a body of literature, some dating back to the last century, that deals with oscillating combustion (resonance burning) and the effect of vibration on flames.[49] Through the application of vibration, improvements in coefficient for boiling[20, 21] and condensation[4] have been reported. Finally—patents, of which a few are cited[2, 44, 54, 60] and miscellany.[6, 29, 61]

The following general comments are offered to anyone considering the application of vibration or pulsation to improve heat-transfer rates:

- For most systems, avoid the quasi-steady state. If an existing exchanger is not performing as it should and the flow is already subject to low-frequency pulsations, consider a damping device to smooth them out.
- Higher frequencies and amplitudes usually give best improvement. Tune for resonance if possible.
- Expect a greater effect at low flow Reynolds numbers than at high, and a greater effect for natural convection than for forced.
- For acoustic vibration applied to natural convection in air, use a sound intensity at least as high as that indicated by Eq. (10) and preferably higher. For other gases, use Eq. (9).
- For pulsation applied to a liquid in forced convection, try to interrupt the flow cyclically just upstream from the exchanger, so as to induce cavitation. The pulsator described earlier can be used for this.

A quick guide to the references

Ref. No.	Oscillating Component	Fluid Used	Frequency Range, (Approx. Cps.)	Improvement in Coefficient (Approx. Max. %)
Natural Convection				
12	Fluid	Air	1,101–6,120	200
17	Fluid	Air	1,660	85
19	Fluid	Air	2,780–4,710	108
25	Fluid	Air	8,000–30,000	75
58	Fluid	Air	1,020–5,000	184
63	Fluid	Air	120	Pos.
27	Surface	Air	39–122	300
56	Surface	Air	11–315	40
60	Surface	Air	Sonic	0
62	Surface	Air	3–20	24
5	Surface	Water	0–40	1,900
34	Surface	Water	0–40	400
22	Surface	Liquid mix	1.7–27	2,300
51	Surface	Oil	400,000	22
21*	Fluid	Air	125–2,400	120
Forced Convection				
7	Fluid	Air	3–15	100
13	Fluid	Air	7–13	50
15	Fluid	Air	5–33	30
16	Fluid	Air	5–40	42
26	Fluid	Air	8,000–30,000	50
28	Fluid	Air	198–322	51
41	Fluid	Air	0.038–0.25	Neg.
52	Fluid	Air	3.3–133	20
59	Fluid	Air	217–500	75
32	Fluid	Gas mix	90	50
3	Fluid	Water	42	10
33	Fluid	Water	0.17–1	40
35	Fluid	Water	0.22–4.4	8
55	Fluid	Water	1–2.9	0
57	Fluid	Water	1.7–8.3	360
64	Fluid	Water	1.7	70
8	Fluid	Water plus water-glycerin	0.25–10	70
31	Fluid	Oil	Not given	300
32	Fluid	Oil	Under 3	65
1	Surface	Air	75–120	130
51	Surface	Air	400,000	0
3	Surface	Water	42	450
51	Surface	Water	400,000	35
53	Surface	Water	0–600	200

* Forced plus natural convection

Nomenclature

A	Surface area, sq. ft.
B	Velocity amplitude, ft./sec.
D	Diameter, ft.
F	Frequency, c.p.s.
h	Instantaneous heat-transfer coefficient, Btu./(hr.)(sq.ft.)(°F.).
h'	Heat-transfer coefficient without oscillation, Btu./(hr.)(sq.ft.)(°F.).
h_m	Time-average heat-transfer coefficient with oscillation, Btu./(hr.)(sq.ft.)(°F.).
H	Double amplitude (distance between extreme positions), ft.
K	Constant, (Btu.)(sec.)^n/(hr.)(°F.)(ft.)$^{n+2}$.
n	Constant, dimensionless.
Q	Heat transferred, Btu.
Re_p	Reynolds number, for penetration of a.c. boundary layer, dimensionless.
Re_s	Stretched-film Reynolds number, dimensionless.
s	Displacement amplitude, ft.
Δt	Temperature-difference driving force, °F.
v_m	Average vibrational velocity, ft./sec.
V	Instantaneous velocity, ft./sec.
V_m	Time-average velocity, ft./sec.
θ	Angle, radians.
μ	Dynamic viscosity, lb.mass/ft.sec.
ρ	Density, lb./cu.ft.
τ	Time, sec.
Φ	Function.
ϕ	Function.
ω	Circular frequency, radians/sec.

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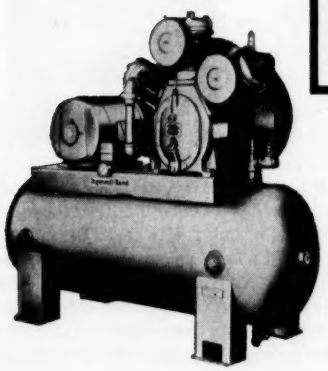

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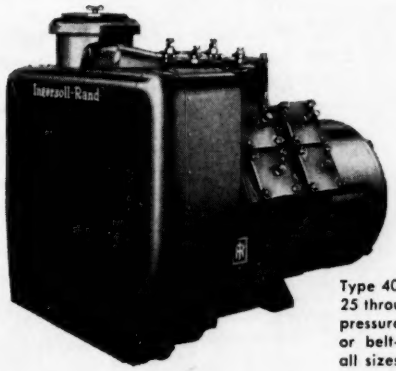

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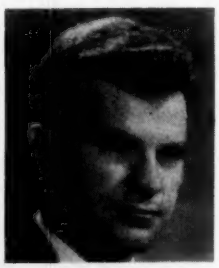
Meet the Author



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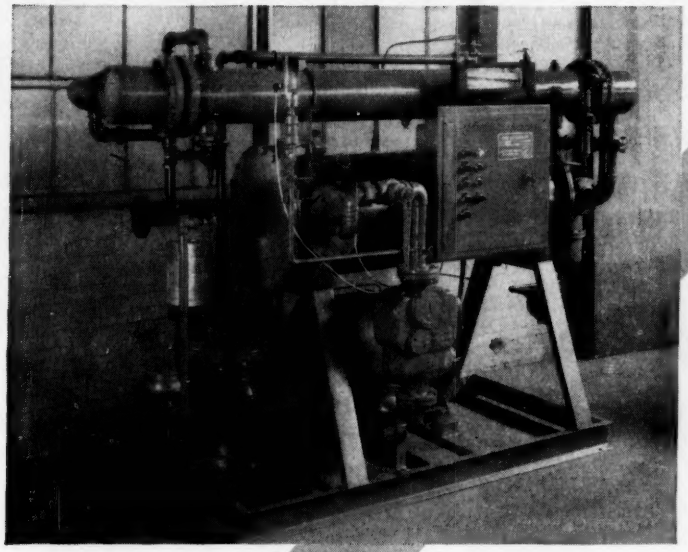

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4 **Set it—forget it.** Once you've set the vernier dial on your Kemp Generator you can walk away and forget about it. Kemp's exclusive carburetor keeps your exact gas-air ratio coming hour after hour—as long as you wish—without further checking or manipulation of controls.

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He is equipped and qualified to advise you on any size and type of generator you may require . . . can also counsel you on dryers and compressors for inert or nitrogen generation systems and heaters. See your C.E.C. Catalog for full listing of Kemp representatives in your area or check your local telephone book. For details on Kemp Inert Gas Generators, write for Bulletin I-10.

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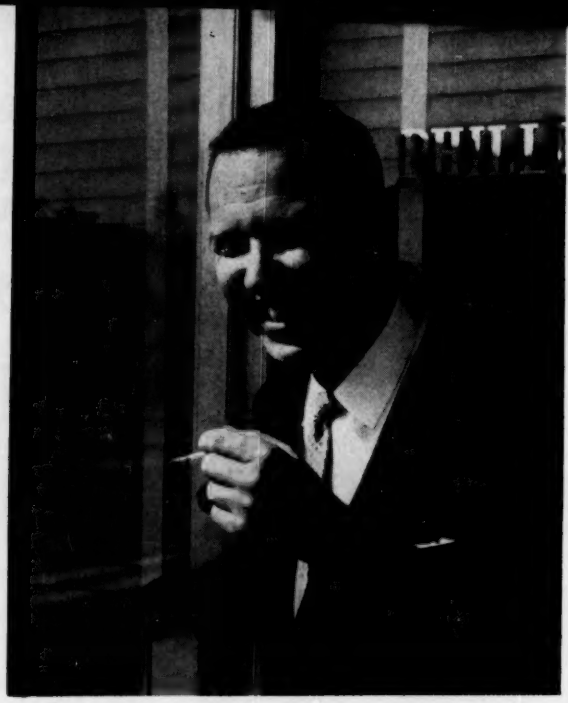

Sales savvy and technical know-how: that's the combination that makes for success of a chemical product or equipment salesman.

Chemical Engineer or CPI Salesman? This Man Is Both

Early one recent, bright California morning, Glenn F. Blinzler of Phillips Chemical Co. arrived at his Pasadena office (above) wondering how the day would challenge his training and know-how. Blinzler, who heads up the plastic sales division's 13-state western district, is a graduate chemical engineer.

Because of his background as a practicing engineer, and the problems he now faces every day in sales work, it didn't take much to trigger an explanation of what he owes to his engineering base. Said he: "A chemical engineer knows research, pilot-plant and manufacturing problems, but he also knows the basics—math and physics and chemistry. They help him solve problems in plastics fabrication, and also to develop himself more rapidly."

"My chemical engineering education, process engineering assignments and work in petrochemical plant design provided me with an understanding of polymers and polymer chemistry. And I got a little insight into plastics fabrication."

Let's take a look at Glenn Blinzler, then. He may not be the typical chemical salesman, but it's typical that more and more chemical process industries firms are looking for salesmen with a technical grounding. This search ranges from recruiting in engineering schools (usually for a sales training program of up to three years duration) to drawing upon experienced engineers within the firm.

The latter path was the one followed by Blinzler. After attending the University of Missouri, he received the bachelor of science in chemical engineering in June 1949. His first job was with Universal Oil Products Co., Des Plaines, Ill., where his main attention was to such petroleum processes as cat cracking and reforming, and to manufacture of antioxidants.

In May 1951, after pilot-plant and service-engineering duties with UOP, Blinzler joined Phillips Chemical Co. at Borger, Tex. As a process engineer, he was continuously involved in process studies to improve the manufacture of butadiene from butane. A year later, after work that included exposure to all the major unit operations, he moved to the company's Bartlesville, Okla., headquarters.

It was in Bartlesville that Blinzler started learning about polyethylene—a product he now sells. As a plant designer, his projects included ethylene and the firm's high-density polyethylene process. So it seemed natural in 1955 to follow the PE process into pilot and semicommercial plants at the research cen-

Leaving office, Blinzler briefs salesmen McKee and Welty.

HIGH-PRESSURE JETS BLAST DEPOSIT-PACKED BUNDLES CLEAN AS NEW

The high-pressure jet unit below is blasting solidly-caked deposits from a heat exchange bundle . . . removing substantially all traces of deposits throughout the bundle, without cutting it apart!

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D. I. S. is a nation-wide industrial service . . . and offers "total" cleaning. For cleaning equipment of *any* kind, *anywhere*, call D. I. S. We'll be glad to show you how to set up a year 'round cleaning program to *keep* equipment operating at top efficiency. Write or call DOW INDUSTRIAL SERVICE, 20575 Center Ridge Road, Cleveland 16, Ohio.

DOW

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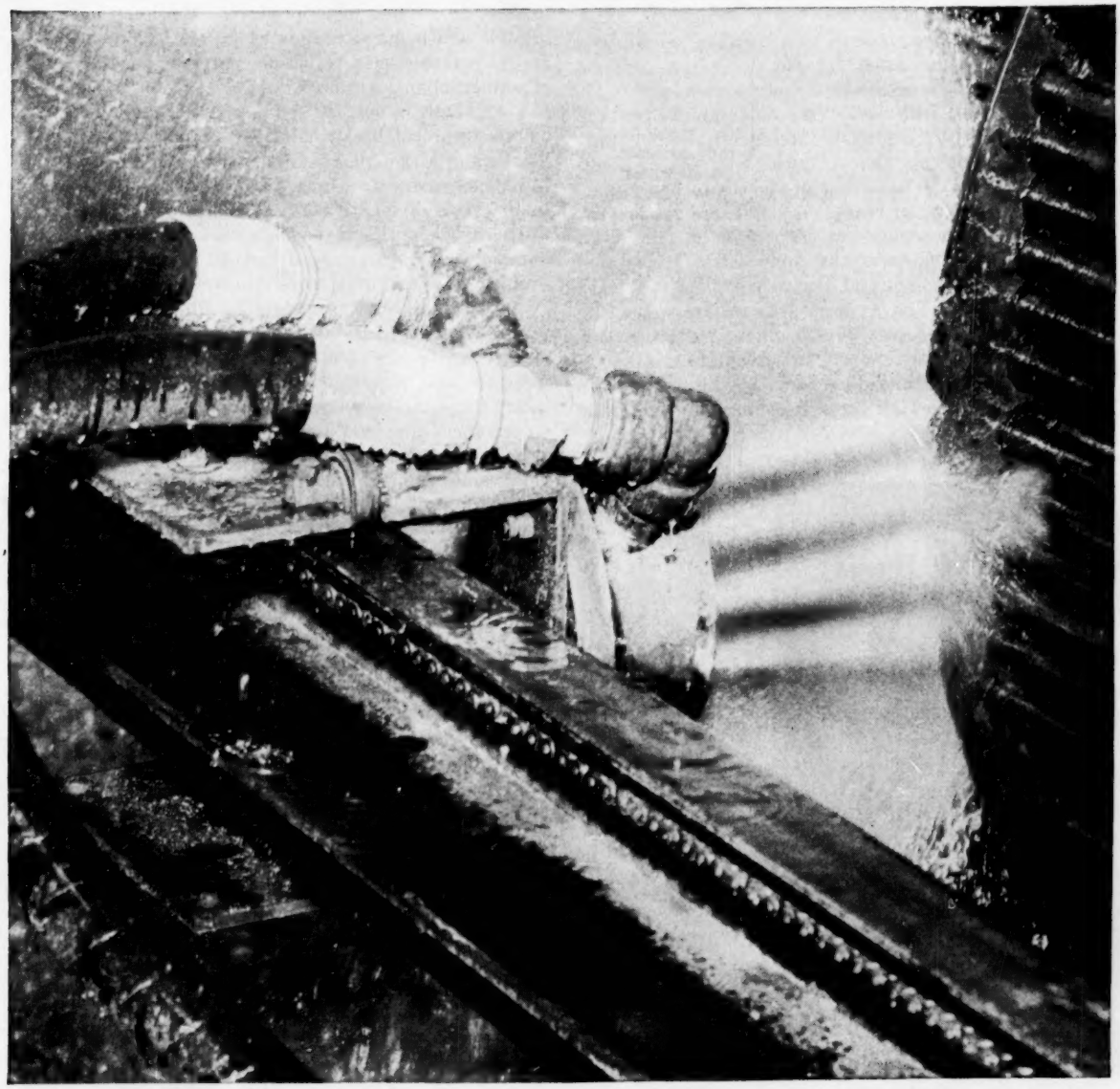


Automatic jet unit removes bundle deposits, without dismantling.

ter. Later in the year, he made the transition to sales, moving back to Chicago as a sales engineer.

Blinzler now says it's virtually impossible to give a play-by-play account of his day. And, actually, that's one of the exciting aspects of it—he has little warning of what he's going to face next. Hence, his solid technical background coupled with his sales experience and a willingness to make good quick decisions serve him well.

In his three years with Phillips in Chicago, Blinzler sharpened his knowledge of end uses of his products. He saw the plastic in appliance and automotive parts, in pipe, in housewares and hospital equipment. From the processing of the resin, his interests turned to injection molding, extrusion, vacuum forming and calendering—all operations of his customers.

Picked for promotion from among other Phillips employees, Blinzler moved to the West Coast in 1958 as district manager of the western district. And evidently it counted some to be a chemical engineer—all the men interviewed for the job, from various company areas, were chemical engineers.

"My training," he says, "has certainly helped the company. I can converse intelligently about unit operations problems that plague end-product manufacturers. And by assisting producers to apply plastics properly, I've increased use of these materials."

After Blinzler arrives at his office, he sits down with his sales engineers and administrative workers to outline selling plans and discuss customer problems. In the sprawling Los Angeles area, where contacting customers may require 100-150 miles of driving each day, planning is particularly important to efficiency.

Blinzler phones ahead, setting up his calls, then leaves his desk to visit these customers and potential customers. At their plants and offices, he visits managers, technical and operating men, and purchasing agents. These calls are in response to many specific needs; but the sum of his work is encouragement, education and promotion of the sale of resin.

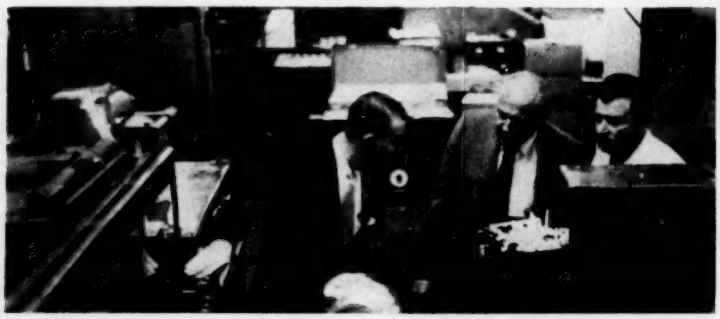
Blinzler's background in chemical engineering is often shared with those of his customers' representatives. He's found, for example, that engineers coping with injection molding find it easy to talk with him about heat transfer and environmental effects in their operations. And in pipe extrusion firms, the common salesman-customer background has helped solve cooling problems, led to faster, more-economic operation.

"One tough nut," Blinzler relates, "was to solve an organic acid packaging problem. The firm was fed up with breakages and corrosion of the containers it had been using, but no plastics resin had been found successful. The acid would react with the container, making it an unsalable product. My knowledge of organic and polymer chemistry got us to a solution—an unbreakable, acid-resistant container based on one of our copolymer resins."

As often as not, the genial district manager calls on his technical background for relationships within his firm. Although he arranges and observes tests in his customers' facilities, he also initiates such work in the sales division's service laboratory. Here, new uses are developed for the chemical company's plastics, and solutions are worked out to specific customer problems. Work of a more fundamental nature may go to the research department of Phillips Petroleum.

In addition to his sales and administrative responsibilities, Blinzler finds time for technical society meetings and conventions. Not only a source of contacts, these meetings permit him to keep up to date on technical advances and industry happenings.

Blinzler obviously prizes his dual engineer-salesman role, values the training he's had in both. He sums it up neatly himself: "The application of chemical engineering enables me to cope with problems across the board in plastics fabrication. That results in increased product sales and bolstered company prestige. And there's great satisfaction in knowing you can tackle a job and bring it to a successful end."



Blinzler calls on Stauffer Chemical Co.'s vice president, C. A. Lindsay, in latter's office before the two go out in plant to discuss a cooling problem.

QUICK CHANGE ARTISTS

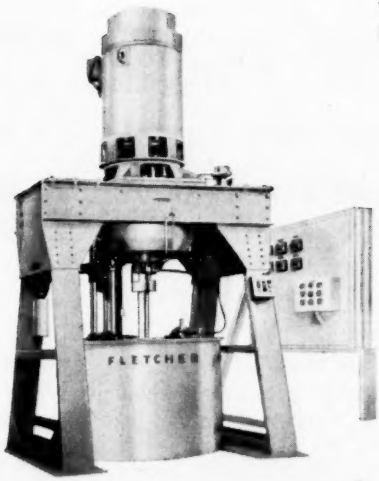
Fletcher-Matics—both Tornado-Matic and Suspend-O-Matic—are high capacity batch processing centrifuges. Once set for optimum cycling conditions—they give **automatic, exact,** repeat performances time after time. The exclusive Fletcher-Matic control system automatically starts, feeds, spins, rinses, brakes, unloads—**then recycles**—on a 24-hour basis, if desired.

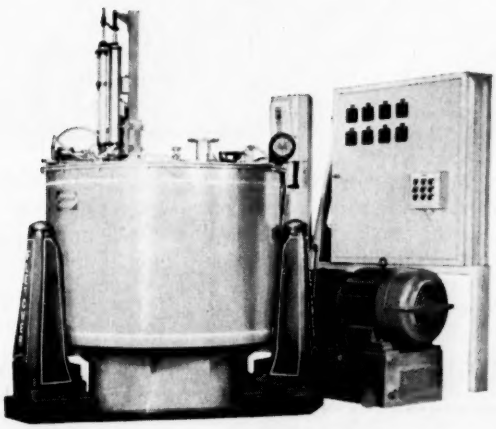
But—Fletcher-Matics are Quick Change Artists, too! When a process **does** require change—when a slight variation in RPM or the addition of a cycle phase is needed to improve the final product—Fletcher-Matics are quickly, easily adjusted **externally**—without need for shutdown. Without a stop—without a stammer, the Fletcher-Matic continues the cycling process—mimicking **immediately, precisely,** and **repeatedly** the inserted changes.

Fletcher-Matics are available in many sizes. They're safety-engineered—any undue variation in speed, phase, or pressure triggers a "safety control center," brings the Fletcher-Matic to a prompt, safe, full stop.

Fletcher-Matics are practically self-operating. Controls and indicators are **so simple** there's no need for specially trained personnel.

Automatic . . . flexible . . . safe . . . stable—the Fletcher-Matic is a showcase of Sharples Centrifugal Skill at Work. See how the Tornado-Matic or Suspend-O-Matic fits into your operation. Write for Bulletin 202-560—Fletcher-Matic High Capacity Centrifuges.





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DOUBLE RUPTURE DISKS COPE WITH SEVERE CONDITIONS

When caught without the right rupture disk for a high-temperature, high-pressure application, use two standard disks with pressure-balancing space between.

Winner of the March Contest*
F. C. FRANKS, *Reichhold Chemicals, Inc., White Plains, N. Y.*

Combinations of temperature and pressure that are too severe for standard rupture disks sometimes occur in chemical processes. When such a situation arose recently at our plant, we did not have time to wait for a special disk to be fabricated so we solved the problem with the arrangement shown.

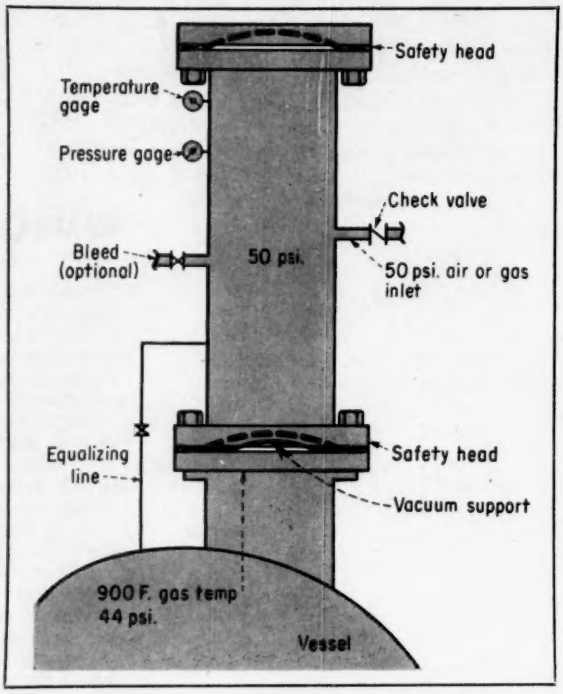
The double-disk arrangement was made with 1 or 2 ft. of pipe extension connecting the two safety heads with air introduced under pressure between them. If air is supplied to the process vessel for reaction purposes, air bleed can be supplied from the same source. Air or gas flow can be continuous or, as in our case, static, depending on the temperature required on the upper disk.

The bottom disk, which is in contact with the hot reactor gases, is under pressure from its top side and is supported by a vacuum support. In our particular application, the pressure between the disks was kept 6 psi. higher than the vessel operating pressure. If an explosion were to occur in the vessel, pressure buildup would take place under the primary disk.

The predetermined bursting pressure of the primary disk must be known for the vessel-operating temperature. Assuming this pressure to be 20 psi. at 900 F., the vessel pressure would have to rise to 64 psi. before the primary disk would rupture. The secondary disk must be sized to burst at 64 psi. at the maintained temperature in order to have both disks burst at approximately the same pressure level.

When the process is started up, the equalizing line is opened so that unbalanced pressures will not develop and exceed the crushing resistance of the vacuum support. This equalizing line is required only if the air supply between the disks comes from a compressor that is not supplying the process system.

This double-disk arrangement can also be used for process vessels containing high-melt-point materials that tend to form a deposit on the underside of the disk, preventing it from bursting at its design rating. The air insulation above the primary disk could be maintained at the temperature required to ensure that deposition of the material would not take place.



COMING JUNE 12
Thermostatic Steam Trap Operates Sump Siphon
By Marvin K. Pierce, April Contest Winner

CHART GIVES SOLUBILITY OF SO_2 IN AMMONIUM BISULFITE

R. A. BONSALL
Brown Co., Berlin, N. H.

Data on the solubility of SO_2 in bisulfite solutions, of interest to the pulp and paper industry, are usually presented as a series of graphs, each at a given temperature, of SO_2 vapor pressure vs. concentration of total SO_2 in solution, with base concentration as a parameter.

Data on the solubility of SO_2 in ammonium bisulfite solutions (Marriner and Whitney, *Paper Trade Journal*, 126, No. 21, 252, 1948) show that the vapor pressure of SO_2 is directly proportional to the concentra-

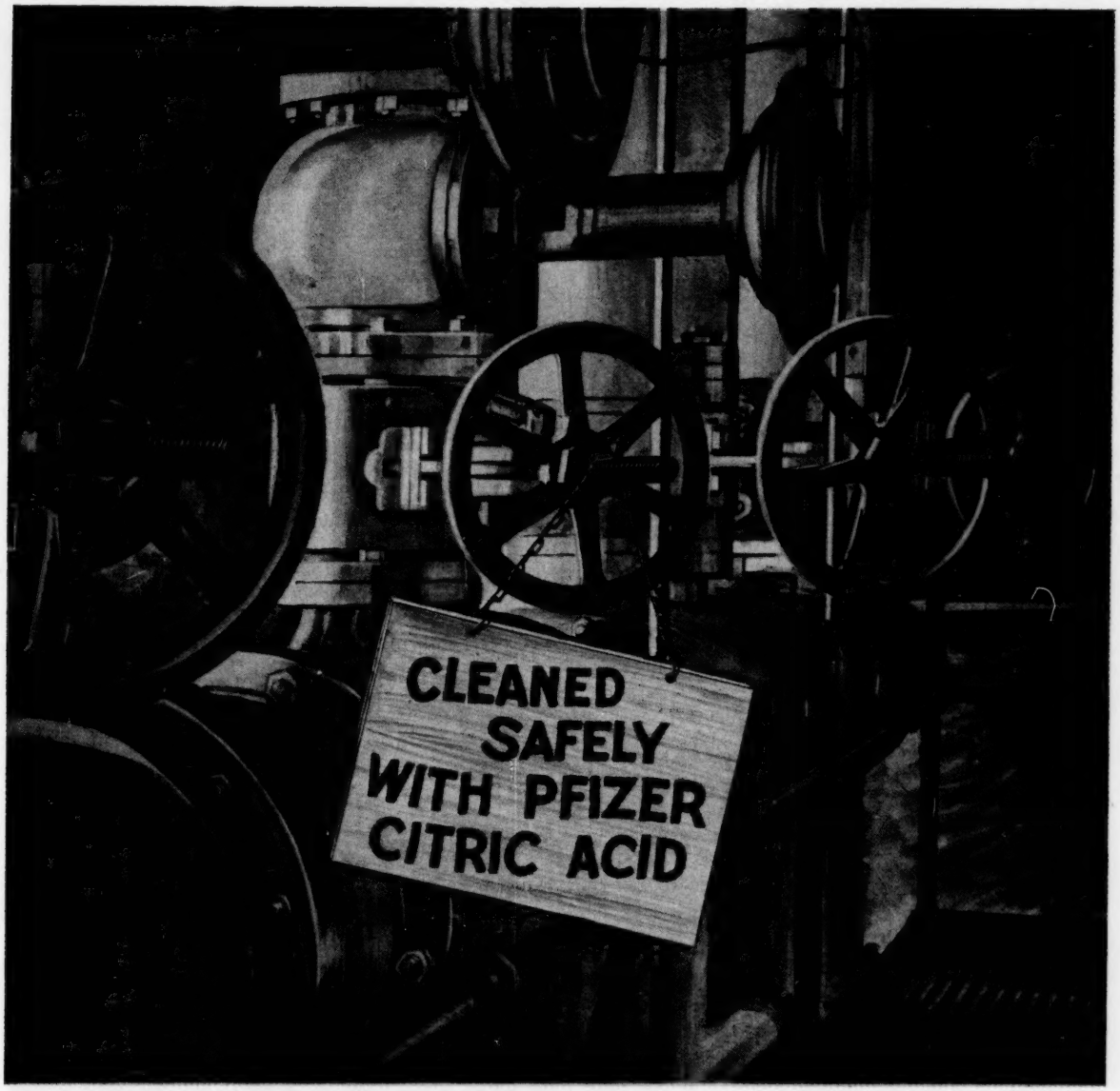
***How Readers Can Win**

$50 Prize for a Good Idea—Until further notice, the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for publication in the Plant Notebook. Each period's winner will be announced in the second following issue and published in the fourth following.

$100 Annual Prize—at the end of each year, the period winners will be rejudged by the editors and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant Notebook Editor, *Chemical Engineering*, 330 W. 42 St., New York 36.



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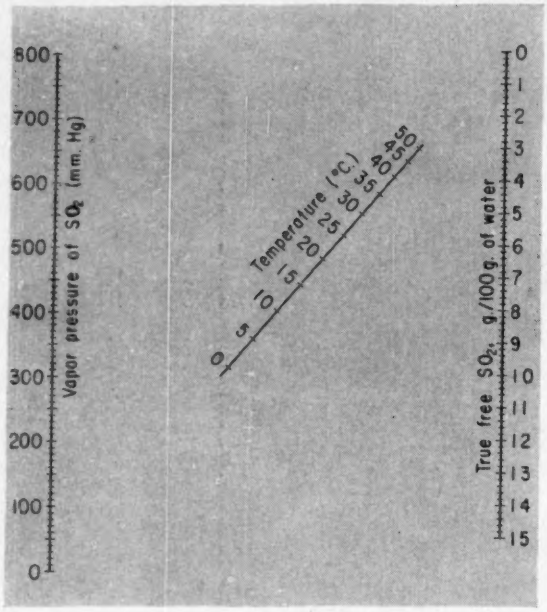


tion of what might be defined as the true free SO_2: the total SO_2 in solution minus that which can be combined with the base as the bisulfite. In pulp mill terminology, true free SO_2 = total SO_2 minus twice the combined SO_2.

Plotting SO_2 vapor pressure vs. true free SO_2 concentration permits great simplification. The data are correlated in the nomograph, which is reproduced at the top of the page.

The points above 25 C. were extrapolated by plotting the log of SO_2 vapor pressure vs. the reciprocal of absolute temperature at several values of true free SO_2 concentration.

An example will illustrate: What is the vapor pressure of SO_2 above a solution containing 10.1 g. of total SO_2 and 2.04 g. of combined SO_2 for each 100 g. of water?

Connect $10.1 - 2(2.04) = 6.02$ on the true free SO_2 concentration scale with 25 on the temperature scale by a straight line and extend the line to intersect the vapor pressure scale. The answer is 547 mm. Hg. The original data give a value of 558.

TEST YOUR CEQ

ROBERT LEMLICH

A certain gaseous substance *X* partly isomerizes to form gaseous substance *Y*. At 1 atm. total pressure, the extent of isomerization at equilibrium is 20% at 50 C., and 60% at 100 C. Estimate the extent of isomerization for equilibrium at 0.5 atm. total pressure and 150 C. *Answer on page 188*

DO-IT-YOURSELF DEVICE STOPS BAROMETRIC FLUCTUATIONS

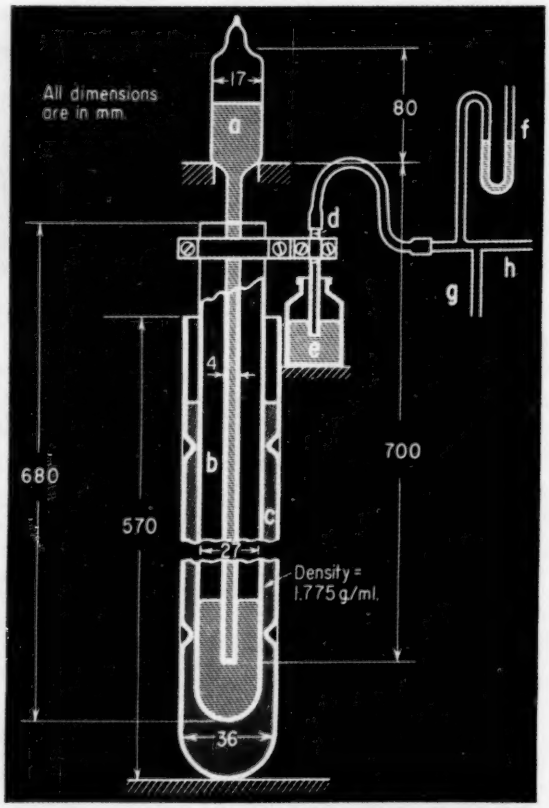
GERHARD HUBNER
Burghausen, Germany

This article describes a device for eliminating the effects of atmospheric pressure.

The device consists essentially of a Torricelli tube *a* in a movable vessel *b* that swims in the fluid of a tube *c*. Fixed to *b* is a vent tube *d* that dips into the mercury in bottle *e* to a variable depth, depending on the position of *b*.

The apparatus must be placed so that the movement of vessel *b* will exactly correspond to changes in the barometric pressure. That is, if the barometric pressure should fall 10 mm., vessel *b* should also fall 10 mm., because of the increased weight of mercury from the barometric tube *a*.

This problem would appear to be easily solved mathematically, but I decided to fix the apparatus empirically, after approximate calculation of the dimensions. This is done by connecting a vacuum pump to the still-open top of the barometer tube and artifically changing the "barometric pressure" by changing the vacuum. The density of the liquid in *c* is then adjusted so that the movement of *b* corresponds exactly to the change of mercury levels in *a* and *b*. At this point, the Tor-



ricelli tube is sealed under vacuum. We used a mixture of hexachlorobutadiene and tetrabromoethane as the liquid in *c*, giving a final density of 1.775 g./ml.

The immersion depth of tube *d* is empirically adjusted to the difference between the desired pressure (usually 760 mm.) and the actual barometric pressure. This is done by passing a small gas flow through *d* and changing the position of *e* until the calculated pressure difference is indicated in manometer *f*.

The apparatus to be controlled is connected at *h*, and nitrogen or air is introduced at *g* to escape at *e*.

A few typical applications of the device are as follows:

- At pressure gages, to give readings independent of atmospheric pressure.
- At pressure regulators.
- In the determination of liquid boiling ranges.
- In the determination of the polymerization activity of monomers.
- In the determination of boiling point = composition diagrams for binary mixtures.
- In biological experiments.

Although this device serves a similar function to the Cartesian manostat that is readily available from laboratory supply houses, it has the advantage of being a do-it-yourself apparatus that is relatively inexpensive to construct.

Also, the Cartesian manostat includes a small volume of gas at the desired pressure. This gas volume is subject to errors caused by valve leakage and temperature changes. In the device described here, however, there is no valve to leak, and temperature changes have no effect because the cross section of vessel *b* is approximately equal to the annular cross section of *c*. The only source of error is evaporation of the liquid in tube *c*. We have found that this error caused only a small adjustment of the immersion depth in bottle *e* after several months' operation.

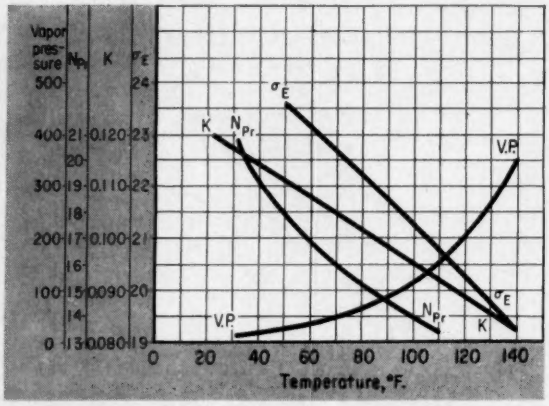
PHYSICAL PROPERTIES OF ETHANOL IN RAPID ROUNDUP

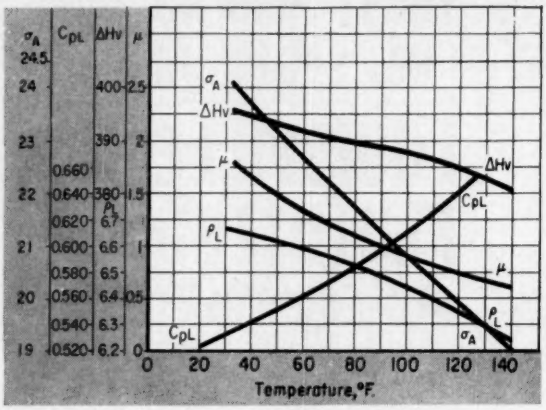
WILLIAM SHULMAN

These two graphs and the table represent most of the published physical data for ethanol. This information will save time for those working with this material.

On the graphs, viscosity μ is expressed in cp.; density ρ_L in lb./gal.; heat of vaporization ΔH_v in Btu./lb.; specific heat c_{p_L} in Btu./lb., °F.; surface tension σ in dynes/cm., both with air and ethanol in the vapor phase; vapor pressure v.p. in mm. Hg; thermal conductivity K in Btu./(hr.) (sq. ft.) (°F.)/ft.; Prandtl number N_{Pr} is dimensionless.

The data were taken from the following sources: "Ethyl Alcohol Handbook," U.S. Industrial Chemicals Co.; "Chemical Engineers' Handbook," J. H. Perry, McGraw-Hill; "Handbook of Chemistry and Physics," Chemical Rubber Publishing Co.; "International Critical Tables," McGraw-Hill.



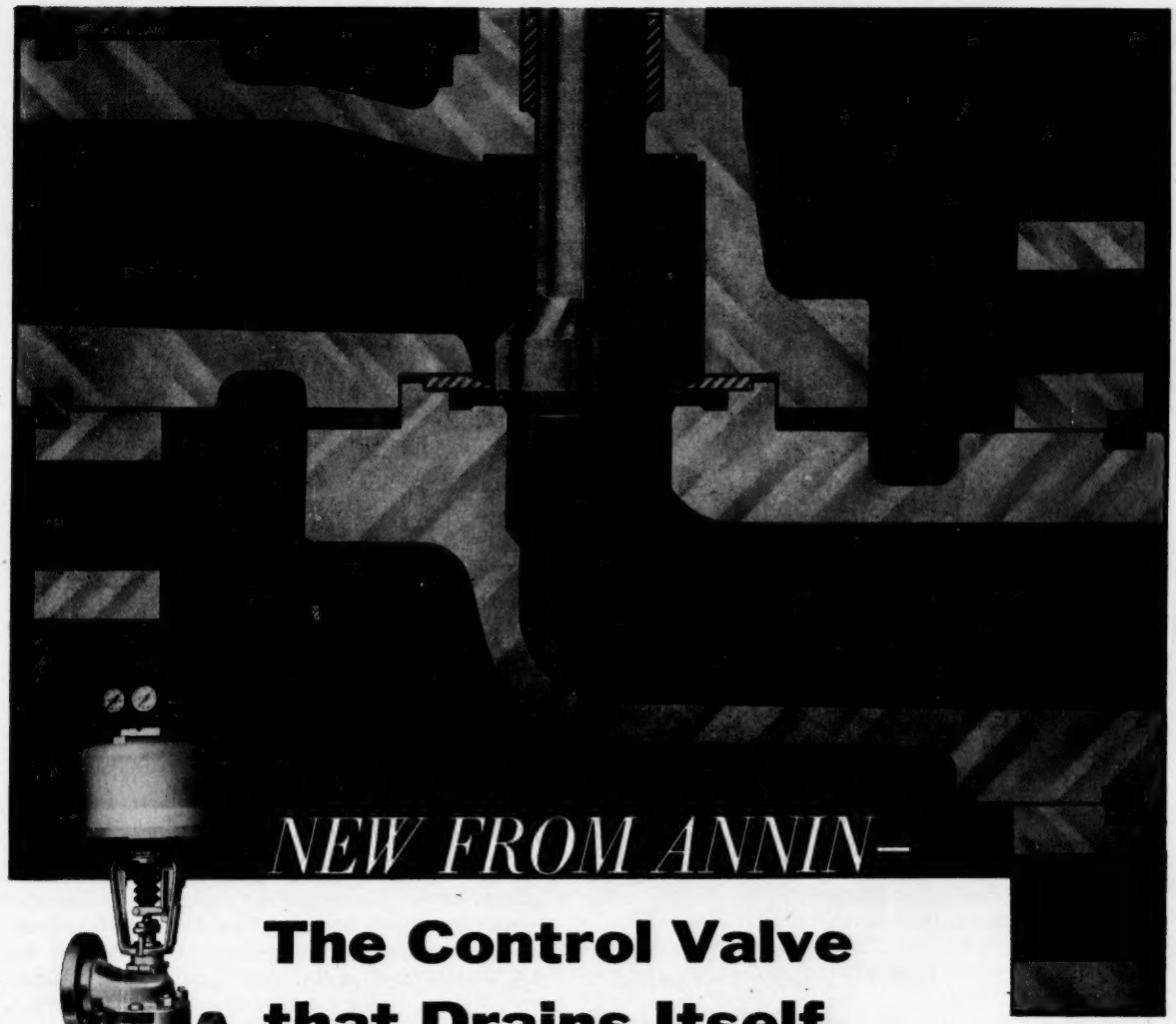


Physical Properties

Molecular weight	46.07
Melting point	−114.4 C.
	−173.9 F.
Boiling point	78.4 C.
	173.1 F.
Refractive index at 20 C.	1.3614
Explosive limits in air	
lower % by volume	3.9
upper % by volume	19.0
Flash point, open cup	70 F.
Auto-ignition temperature	738 F.
Thermal coefficient of expansion	0.00113/°C.
	0.00063/°F.
Heat of combustion at 20 C.	12,800 Btu./lb.
	32.76 kcal./mole
Heat of formation at 25 C.	−66.36 kcal./mole
Free energy of formation at 25 C.	−41.77 kcal./mole
Entropy at 25 C.	38.4 cal./mole °K.
Heat of fusion at melting point	1.187 kcal./mole
	46.37 Btu./lb.

Critical Constants

Temperature	243.1 C.
	469.6 F.
Pressure	63.1 atm.
	927.3 psia.
Density	0.2755 g./ml.
	17.19 lb./cu. ft.

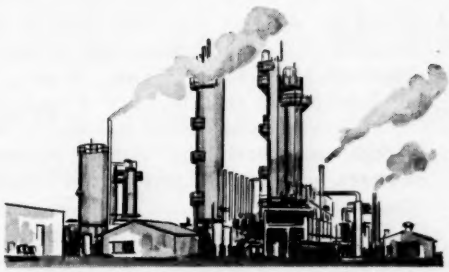


NEW FROM ANNIN—

The Control Valve that Drains Itself

ANNIN'S MODEL 1900 SELF-DRAINING CONTROL VALVE is designed to completely drain the line and valve body of corrosive fluids, slurries, and other flowing media which contaminate or tend to set up and harden in the system. Body and trim are designed so that all surfaces slope downstream, making the valve completely self-draining when installed in either the horizontal or vertical position. All body parts are interchangeable with other Annin models, allowing an option of globe, angle or three-way body patterns. Model 1900 is designed to accept all standard actuators—Pneumatic Domotor, Electro-Pneumatic, Electro-Hydraulic, Cylinder or Manual.

Send for latest technical information.



Model 1900 has many applications in the process industries, both in batch operations which require cleansing of the system after each run and in continuous processes after the system is shut down. Unique self-draining design of the valve body eliminates problems of fluid contamination, fermentation, toxicity and solidification.

Annin **VALVES**

THE ANNIN COMPANY
1040 South Vail Avenue,
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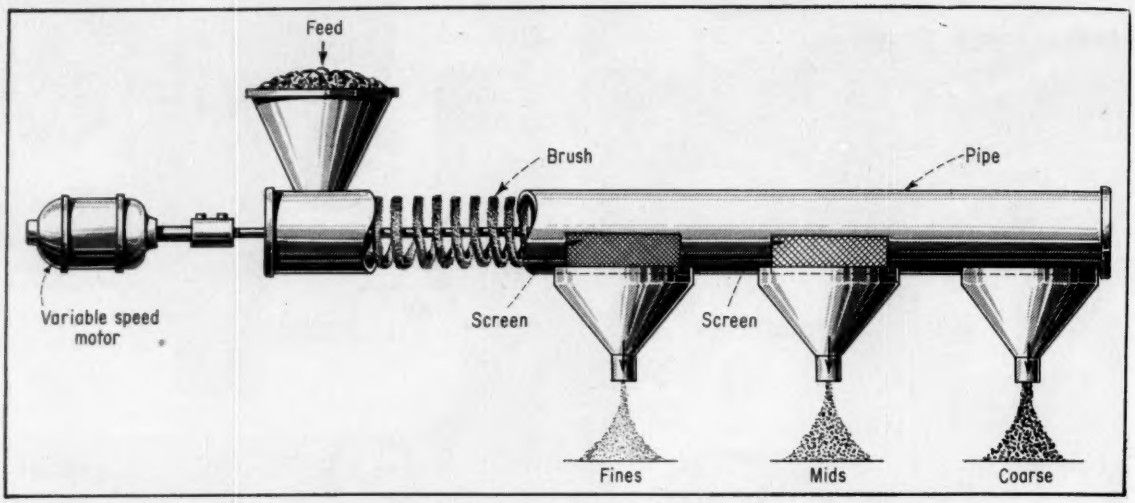

SPIRAL BRUSH CAN FEED OR SCREEN DRY MATERIAL

SAM A. JONES
International Minerals & Chemicals Corp.
Mulberry, Fla.

Here's a device that feeds solids into a process at a variable rate or takes a solids sample and screens it for various sizes. The equipment consists of a variable-speed motor that drives a shaft on which is mounted a spiral brush. The brush, which replaces the usual screw, runs in a housing made from ordinary pipe.

One useful feature of this feeder is its simplicity. The bristles center the brush in the housing, thus eliminating the need for bearings or internal shaft supports. Use of the brush instead of a metal screw also considerably reduces weight. We have fabricated these units with brush diameters ranging from ½ in. to 2 in. and lengths up to 3 ft.

Although devised principally as a feeder, the unit serves another important function, as shown in the illustration. Here, it is set up to take a continuous sample and screen it for size distribution. Portions of the bottom of the housing are replaced with screens —fine mesh nearest the feed end, coarse mesh at the discharge end. The feeder can then be placed so that its hopper receives material from the process stream.

Any size sample within the capacity of the unit can be taken by adjusting the brush speed via the variable-speed motor. As the material passes over the screens, the wiping action of the brush helps to push particles through the various size screens. Later, an operator need only weigh the different fractions.

Answer to Test Your CEQ

For the reaction $X \rightleftarrows Y$ at equilibrium, $K = f_y/f_x$, where K is the equilibrium constant and f is fugacity. However, at a pressure of 1 atm., gases are nearly ideal in behavior, so that fugacity = partial pressure p. (Futhermore, what little nonideality exists should largely cancel in the ratio because we are dealing with isomers.) Thus, the expression for K can be simplified to $K = p_y/p_x$.

Substituting Dalton's Law, which states that $p = (n/\Sigma\, n)P$ (where n = number of moles and P = total pressure), permits us to simplify further to give $K = n_y/n_x$. Now, based on 1 mole of isomerized mixture, $n_x = 1 - n_y$. Substituting for 50 C. yields $K = 0.20/0.80 = 0.25$. For 100 C., $K = 0.60/0.40 = 1.5$.

The effect of temperature takes place via the thermodynamic relationship $d \ln K/dT = \Delta H°/RT^2$. The heat capacities of isomers usually do not differ markedly, so that the standard heat of reaction should be substantially constant over the temperature range. Thus, we can separate variables and integrate without limits as shown by the following:

$$\int d \ln K = \frac{\Delta H°}{R} \int \frac{dT}{T^2}$$

or

$$\ln K = \frac{-\Delta H°}{RT} + \text{constant}$$

The above equation means that the two known points can be plotted on semilog paper, with K on the log axis and $1/T$ on the arithmetic, with a straight line drawn through the points. Extending the line to the third $1/T$, which in the present problem is $1/(150 + 273)$, permits us to read a K of 5.8 for this temperature. Substituting in $K = n_y/(1 - n_y)$ and solving for n_y yields 0.85. The extent of isomerization at 150 C. is therefore 85%.

Note that the given reduction in the total pressure has no effect. Similarly, the pressure of any gaseous inerts would also have no effect.

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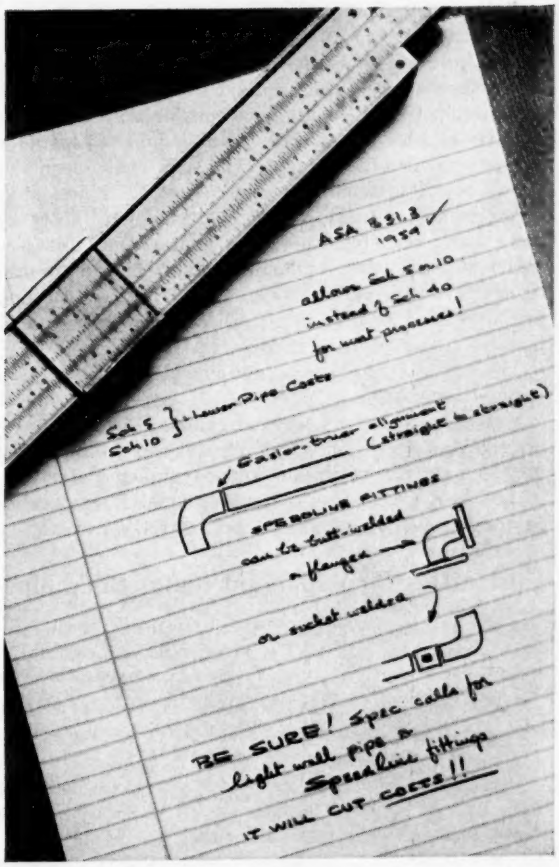

If you're familiar with the latest issue of the Code for Pressure Piping ASA B31.3, you know process piping standards have changed. Pressure-Temperature operating conditions should be re-evaluated. Now *your* specifications can take advantage of economical *light wall* pipe and improved *Speedline fittings design* to meet the most critical process line requirements!

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CE Cost File

No. 52: Process-Piping Materials

OTTO MENDEL
Chief Piping Estimator
Chemical Construction Corp., New York, N. Y.

Piping costs in fluid-handling chemical plants can easily run between 10 and 20% of total plant costs. There's no easy shortcut to estimating these costs.

Selection of the "best" material from a service and cost standpoint will contribute considerably to reducing over-all plant costs. But the abundance of metallic and nonmetallic piping materials now available make such a selection somewhat complicated. The first step in an economic study should be to compare costs of these materials, since there is a wide range of prices.

Of course, in any economic evaluation, cost of materials is not the entire story. Valves, flanges, fittings, prefabrication of pipe in a fabricator's shop, and field installation, have to be considered.

The two charts below do not consider valve or field-installation costs.

Valve costs have been disregarded because body materials of valves are relatively easy to establish and may remain the same for various piping materials.

And field-installation costs will vary widely depending on basic labor rates, local productivity, availability of qualified labor. This could be a separate study.

Table I is a list mainly of nonmetallic materials with (1) flanged, (2) screwed or welded fittings.

Most pipe used with flanged fittings requires precutting to length, and flange installation, in the supplier's factory. Some of the listed materials are available for field cutting and flanging, but the cost of such operations is much higher than factory installations, and it is not considered in this comparison.

The cost basis for flanged materials in Table I is as follows: 100 ft. of 3-in. pipe, ten 3-in. flanged 90° ells, one 3-in. flanged tee, ten pairs of 3-in. flanges.

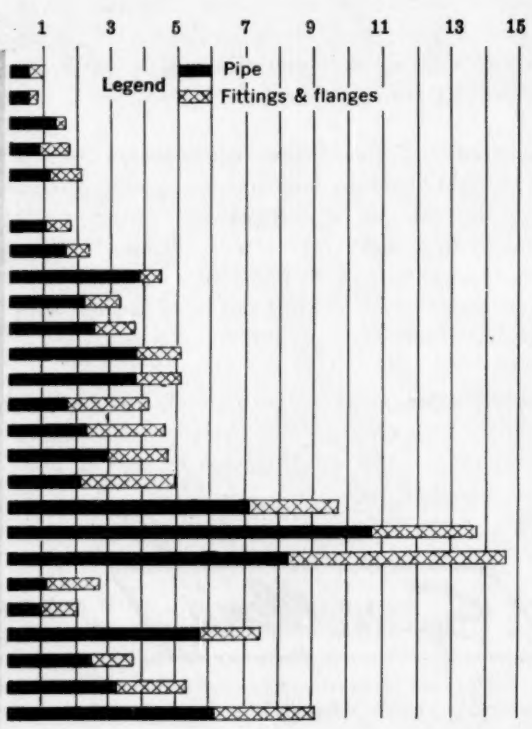
Cost basis for pipe with screwed or welded fittings (mainly plastic pipe that is best fabricated at the job site) is: 100 ft. of 3-in. pipe, ten 3-in. 90° ells, one 3-in. tee, four 3-in. flanges.

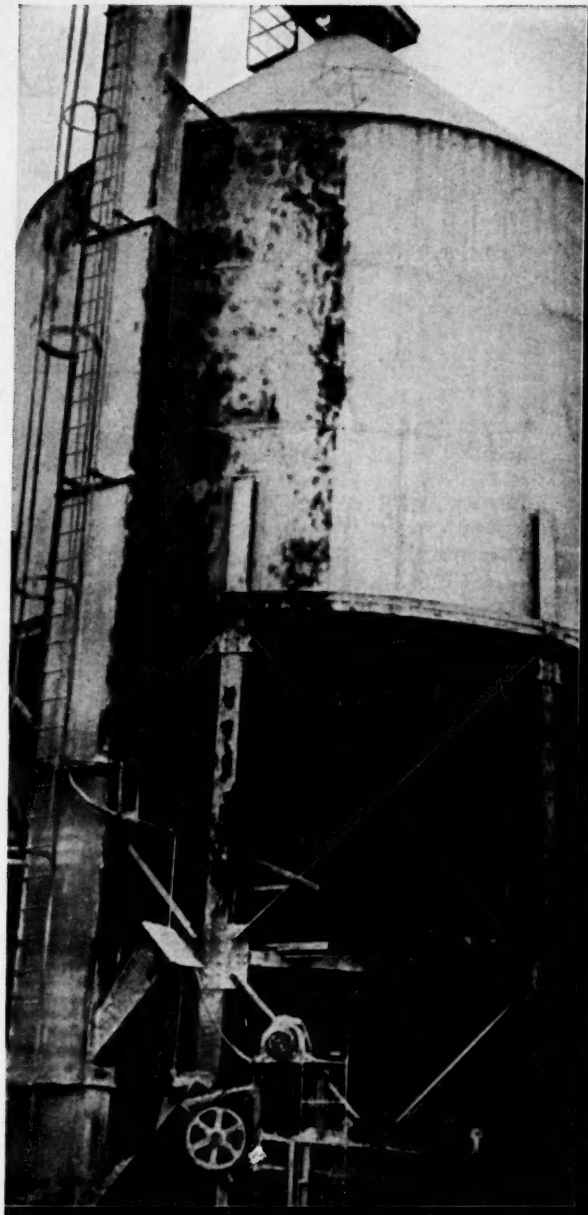
Table II lists various piping materials that lend themselves to prefabrication but also could be completely fabricated at the job site. As in Table I, cost of these materials vary widely depending on quantity of pipe or fittings used and it was necessary to arbitrarily establish a common base.

The following is the basis for the cost comparisons in Table II: 100 ft. of 3-in. pipe, ten 3-in. 90° weld ells, one 3-in. weld tee, four 3-in. weld neck flanges,

Cost ratios for important nonmetallic pipe—Table I

Pipe Material	Connection	Cost Ratio
Carbon Steel (C. S.), A-53, seamless	Welded	1.00
Carbon steel, A-53, welded, galvanized	Screwed	0.84
Wrought iron, galvanized	Screwed	1.61
Unplasticized polyvinyl chloride	Sock. weld	1.79
Unplasticized polyvinyl chloride	Screwed	2.09
ABS copolymer (acrylonitrile-butadiene-styrene)	Screwed	1.83
Styrene copolymer	Screwed	2.31
Acrylonitrile-butadiene	Screwed	4.54
Epoxy resin, glass reinforced	Flanged	3.26
Furane resin, glass reinforced	Flanged	3.74
Phenolic resin, asbestos reinforced	Flanged	5.08
Furane resin, asbestos reinforced	Flanged	5.08
Carbon steel, lead lined	Flanged	4.11
Carbon steel, PVC lined	Flanged	4.76
C.S., polyvinylidene-chloride lined	Flanged	4.83
Carbon steel, rubber lined	Flanged	4.99
Carbon steel, chlorinated-polyether lined	Flanged	9.84
Carbon steel, glass lined	Flanged	13.72
Carbon steel, TFE-fluorocarbon lined	Flanged	14.69
Carbon steel, phenolic-resin coated	Flanged	2.83
Cast iron, class 150	Flanged	2.03
Silicon iron	Flanged	7.47
Porcelain	Flanged	3.71
Glass (armored)	Flanged	5.36
Graphite (impervious)	Flanged	9.06





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Tested and proven on the job. After three years of continual exposure to corrosive fumes, moisture and salt spray, CORLAR coating on right side of lime tank is still in good condition. Commonly used phenolic resin coating on left side, however, has deteriorated completely—permitting rust and corrosion to take over.

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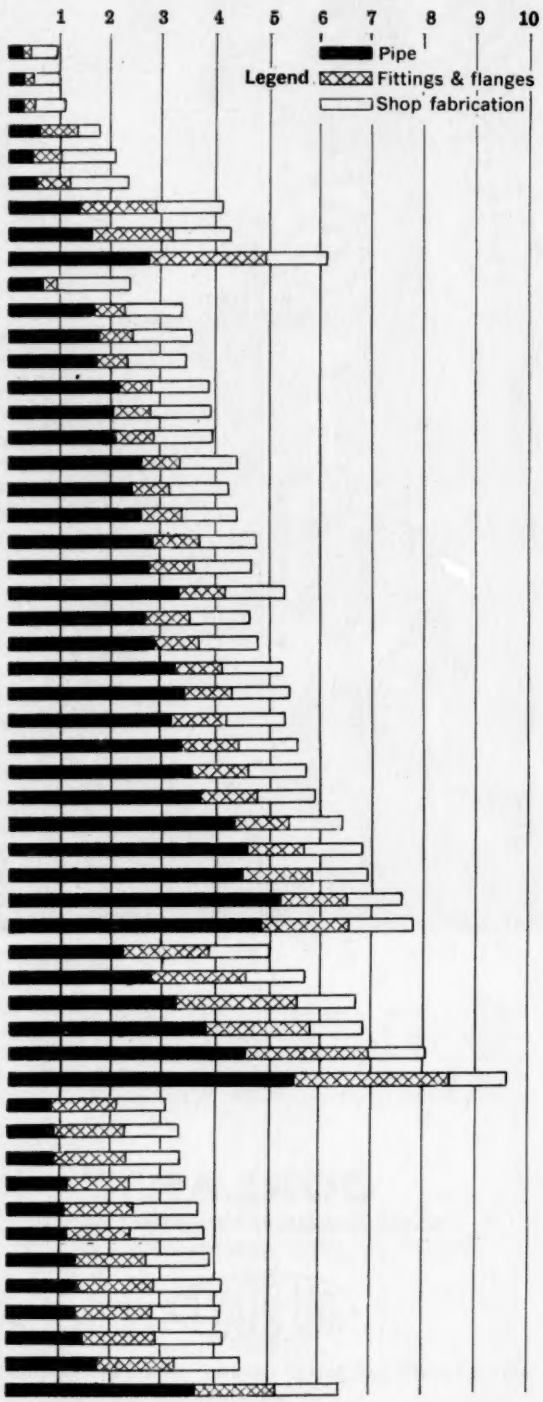
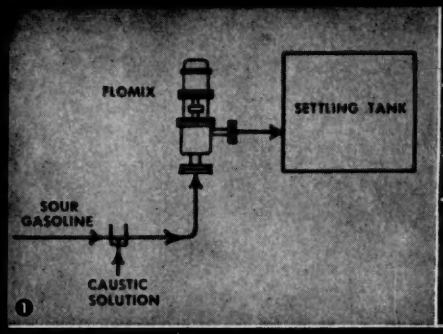
twenty-four 3-in. shop butt welds. Heat treatment where required under ASA code for pressure piping is included in shop-fabrication costs.

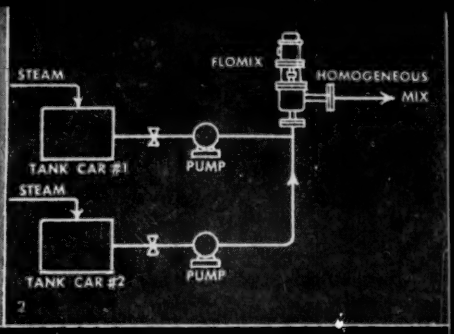
Both charts have carbon-steel pipe, A-53, seamless, as the base material, with a cost ratio of 1. But the base cost for Table II includes shop fabrication, while base cost for Table I includes only pipe, fittings and flanges. All costs have been corrected to Sept. 1960.

Cost ratios for shop-fabricated metallic pipe—Table II

Pipe Material	Pipe Sched.	ASTM Spec.	Cost Ratio
Carbon steel, welded	40	A-53	0.94
Carbon steel, seamless	40	A-53	1.00
Carbon steel, seamless	40	A-106	1.03
Wrought iron	40	A-72	1.84
Aluminum 3003 or 6063	40	B-241	2.08
Aluminum 6061	40	B-241	2.24
85 red brass	40	B-43	4.06
Copper	40	B-42	4.19
70-30 cupro-nickel	40	B-165	6.06
Nickel steel	40	A-333	2.31
Stainless steel, Type 304, welded	10	A-312	3.33
304, seamless	10	A-312	3.47
304L, welded	10	A-312	3.44
304L, seamless	10	A-312	3.86
321, welded	10	A-312	3.88
321, seamless	10	A-312	3.94
347, welded	10	A-312	4.37
347, seamless	10	A-312	4.19
316, welded	10	A-312	4.38
316, seamless	10	A-312	4.76
316L, welded	10	A-312	4.66
316L, seamless	10	A-312	5.27
304, welded	40	A-312	4.60
304, seamless	40	A-312	4.78
304L, welded	40	A-312	5.20
304L, seamless	40	A-312	5.38
321, welded	40	A-312	5.32
321, seamless	40	A-312	5.49
347, welded	40	A-312	5.71
347, seamless	40	A-312	5.90
316, welded	40	A-312	6.49
316, seamless	40	A-312	6.79
316L, welded	40	A 312	6.92
316L, seamless	40	A-312	7.57
Carpenter 20	10		7.88
Monel	10	B-165	4.99
Nickel	10	B-161	5.68
Inconel	10	B-167	6.66
Monel	40	B-165	6.89
Nickel	40	B-161	8.01
Inconel	40	B-167	9.63
Carbon-moly	40	A-335 P-1	3.11
Chrome-moly, ½ Cr-½ Mo	40	A-335 P-2	3.25
Chrome-moly, 1 Cr-½ Mo	40	A-335 P-12	3.29
Chrome-moly, 1¼ Cr-½ Mo	40	A-335 P-11	3.43
Chrome-moly, 1½ Cr-¾ Mo	40	A-335 P-3	3.64
Chrome-moly, 2 Cr-½ Mo	40	A-335 P-3b	3.72
Chrome-moly, 2¼ Cr-1 Mo	40	A-335 P-22	3.92
Chrome-moly, 3 Cr-1 Mo	40	A-335 P-21	4.09
Chrome-moly, 5 Cr-½ Mo	40	A-335 P-5	4.07
Chrome-moly, 5 Cr-½ Mo, Si	40	A-335 P-5b	4.18
Chrome-moly, 5 Cr-½ Mo, Ti	40	A-335 P-5c	4.45
Chrome-moly, 5 Cr-½ Mo, Cb	40	A-335 P-5c	6.42







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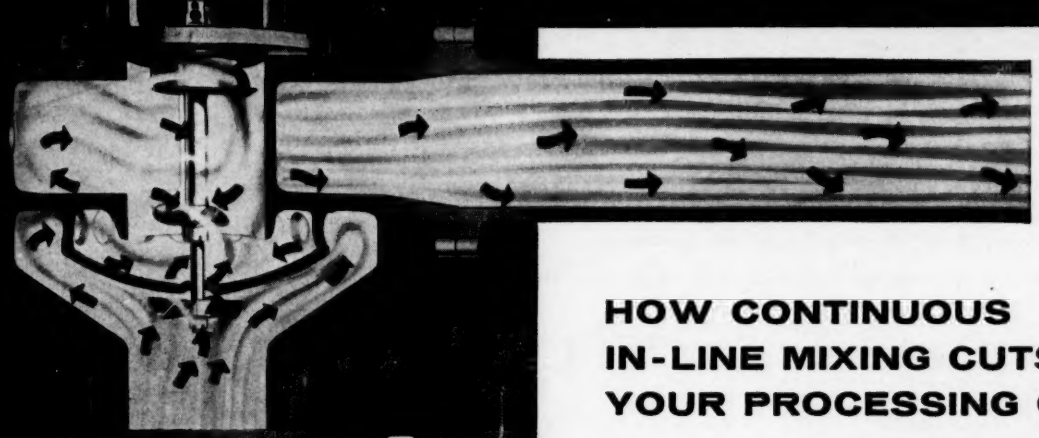

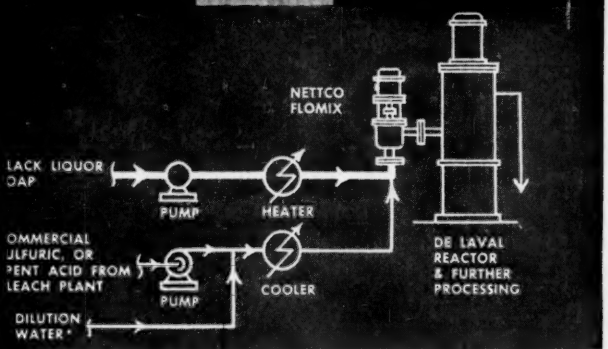

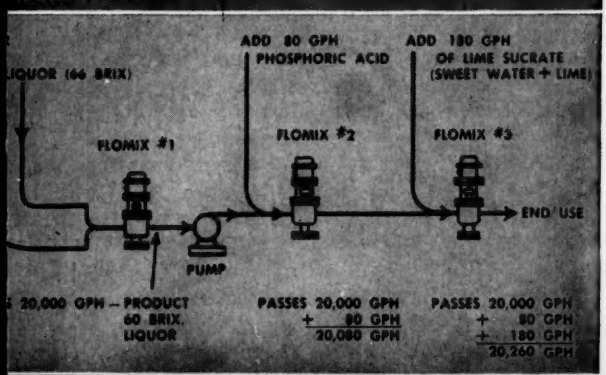

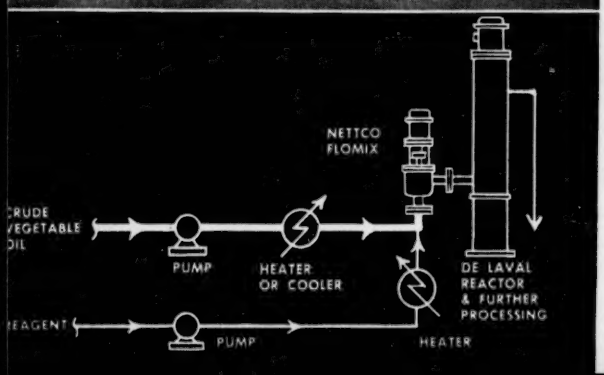

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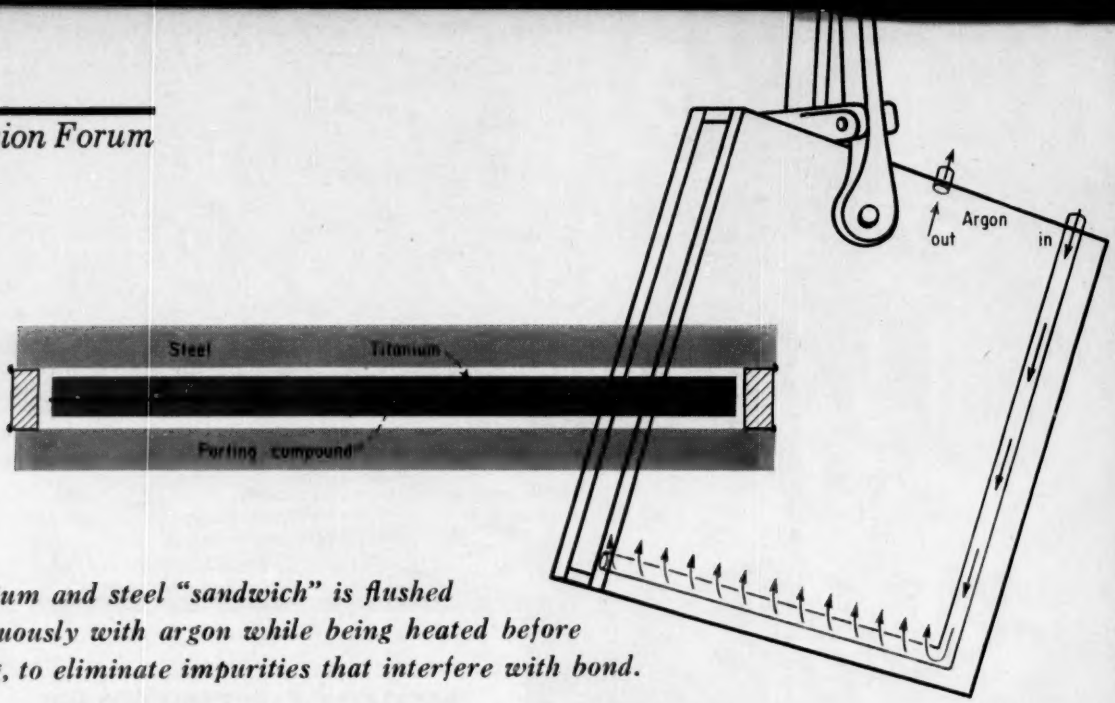


Titanium and steel "sandwich" is flushed continuously with argon while being heated before rolling, to eliminate impurities that interfere with bond.

New Process for Ti-Clad Steel Plate

ROY V. HUGHSON, *Assistant Editor*

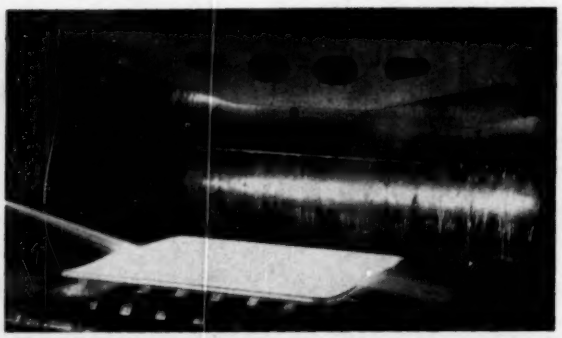
Titanium-clad steel plate is being produced at the Lukens Steel Co. One of the most corrosion-resistant of metals, titanium's high price and the difficulties in its fabrication have limited its use. Titanium-clad steel plate is both easier to handle and somewhat cheaper than solid titanium.

One of the first orders for this material came from Du Pont, which specified Ti-clad plate for a reactor to be used in one of its processing plants. The order calls for one plate, 207 × 64½ × ⅝ in., 22% titanium on A-204 backing steel, and a head made of the same material.

Ti-clad is fairly easy to make on a laboratory scale, and long ago there were predictions of widespread use. However, going from laboratory to production scale was beset by more than the usual number of difficulties. Chief among these was the problem of keeping the steel and titanium surfaces absolutely clean and free from impurities such as oxides and nitrides, which would be detrimental to the strength of the bond between the two materials.

Then, too, titanium reacts with iron at elevated temperatures to form a brittle alloy. This alloying may take place any time the clad material is subjected to high temperatures—during rolling, hot forming, stress relieving, welding and the like. If the bond deteriorates to a great enough degree, the titanium layer may actually fall off the backing plate.

▶ **Use an Interlayer?**—Most of the previous solutions to the bonding problem have involved the use of a layer of another metal between the steel and the titanium. One such metal is silver. But silver is expensive, $1.15 to $1.40 a troy ounce, and requires exceedingly careful control of time, temperature and



Rolling the steel-titanium pack to bond the layers together.

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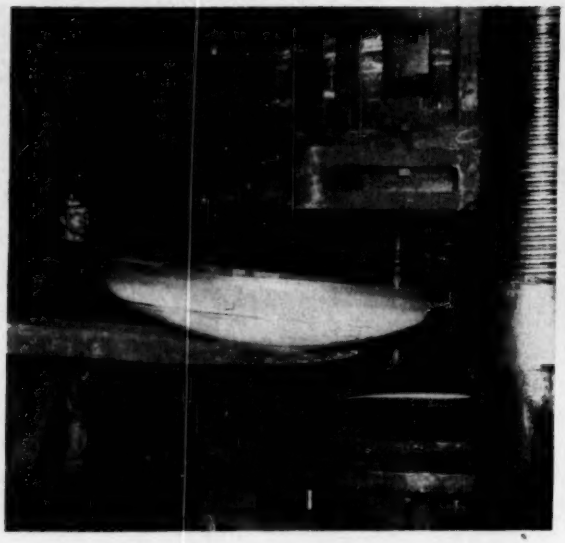
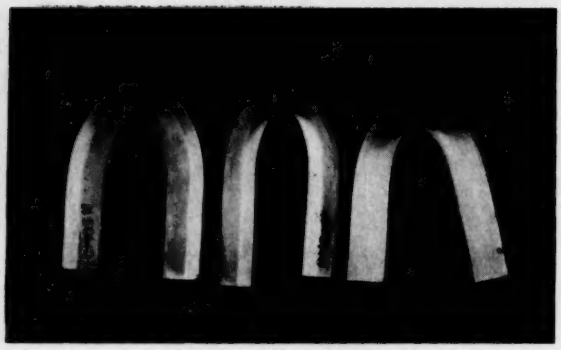




Laboratory test bands (above), made with titanium on the outside, inside and side of the bent specimen, may show perfect ductility but the real test comes in the plant (left) when the plate is actually formed into a dished head.

heating atmosphere. Although Lukens was successful in making a silver-interlayer Ti-clad in the laboratory, the company felt it would be almost impossible to duplicate the conditions in mill-scale production.

Plating titanium with nickel, as is done when cladding stainless steel to the backing plate, doesn't work with Ti-clad. The nickel combines with the titanium to form the ubiquitous brittle alloy that plagues titanium users.

Lukens has worked out a process of bonding the titanium directly to the backing plate without the use of an intermediate metal. In the lab, either vacuum or an argon flush was used to prevent oxygen or nitrogen from reaching the steel-titanium interface, but in the mill it was found that only the argon flush technique was practicable. It's hard to get a good vacuum seal in the first place, and harder to keep it during the outgassing that occurs during heating.

▶**How Ti-Clad's Made**—In general, Ti-clad is made in much the same way as stainless-clad. In essence, a sandwich is made of two plates of titanium between two plates of steel. (See the diagram on p. 194.)

The contiguous sides of the two sheets of titanium are coated with a parting compound so they won't fuse to each other. The titanium sheets are somewhat smaller than the steel plates and are surrounded with a "picture frame" of steel bars somewhat thicker than the titanium plates. This provides a space between the titanium and steel plates that can be flushed with argon during the heating process.

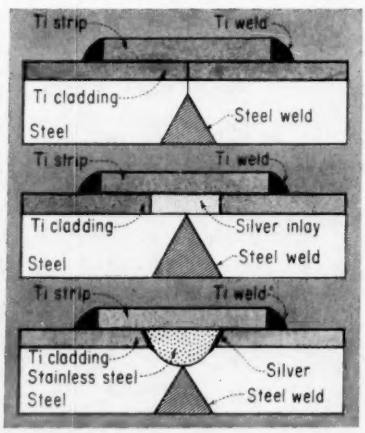
Argon is introduced through a perforated tube that rests inside the sandwich and is connected through a tube to a flexible hose on the outside of the pack. The entire pack is welded closed, with the exception of the openings for supplying and removing the argon.

The pack is then placed in a soaking pit where it is heated. Argon flushing continues during the entire soaking period. (The temperature limit before rolling is between 1,700 and 1,750 F.) The pack then goes into the rolling mill where it is reduced in thickness; the heat, and pressure of the mill rolls, bonds the steel and titanium layers. A reduction of at least three to one is required for good bonding.

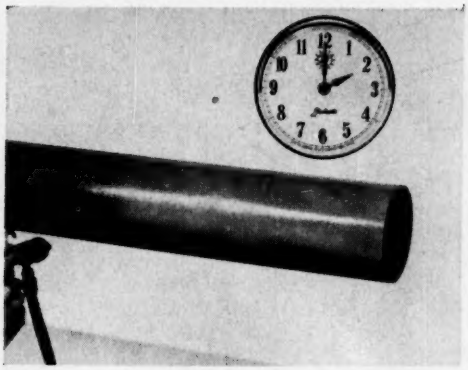
▶**Sizes**—The maximum thickness of Lukens' Ti-clad plate is presently 1¼-in., the minimum is ⅜-in. The titanium layer can have a thickness of no more than $\frac{1}{16}$-in. Lukens can roll plate to a maximum width of 96 in., having a length to width ratio of three to one. The minimum practical width is about 48 in.

Lukens still does not have Ti-clad in full-scale production but it is taking orders on a developmental basis. That is, each order is evaluated and quoted separately; consequently, no price schedule is available.

Forming Ti-clad presents certain difficulties. One of these is the springback problem, caused by the fact that the titanium is stronger than the steel. Deforming the material enough so that it is the proper shape after springback is one solution. Hot-forming also helps, but the temperature must be carefully controlled if the steel-titanium bond



Methods of welding Ti-clad to prevent embrittlement at the interface.



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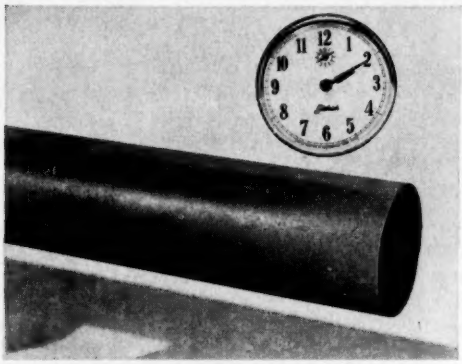

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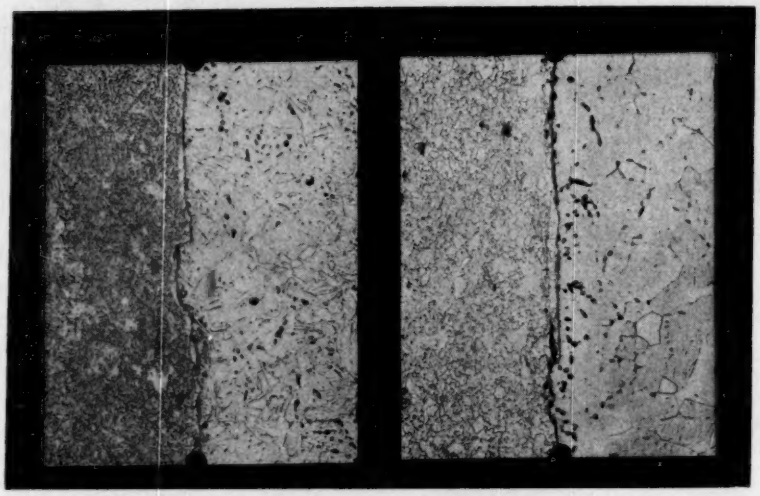
When required for severe chemical exposures, Dimetcote plus Amercoat No. 99 provides a revolutionary 2-COAT system!

Amercoat No. 99 is a high solids vinyl that easily attains a 6-mil dry film thickness in one airless spray coat . . . a 5-mil thickness in two coats by conventional spray methods; forms a tough, flexible film with excellent chemical and weather resistance. Tests prove the Dimetcote/Amercoat No. 99 two-coat combination outperforms other maintenance systems — even those requiring up to 5 coats!



Titanium clad on a steel. At left, in an "as pressed" condition; right, after heating to 1,400 F. eight times, holding two hours each cycle.

is to be preserved. Lukens prefers to form at about 1,200 F., and feels that 1,600 F. is the maximum permissible forming temperature.

▶ **Cutting** — Care must be taken when cutting Ti-clad plate to avoid affecting the bond at the edge. Shearing is not recommended as it weakens the bond. Lukens cuts by abrasive methods or by machining.

▶ **Welding** — Here is one of the basic problems in the use of titanium-clad. Unless extreme care is taken, welding will cause deterioration of the steel-titanium bond. A number of ingenious ways around the problem are possible, and are illustrated on p. 196.

In the first of these methods, the backing steel is welded, but not up to the steel-titanium interface. Then a cover plate of titanium is welded to the titanium layer, covering the crack. This type of weld is less strong than some of the others in that there is an unwelded portion in the plate.

The second method shown uses a silver inlay to prevent contact between the titanium and the steel. The titanium layer is cut back from the weld point, and the steel is welded from the back. A layer of silver is fused to the surface of the steel and overlaid by a strip of titanium, which is then welded.

In the third method shown, the titanium and steel is cut back as illustrated. The steel plate is welded from the rear as usual. A barrier of silver is laid down to protect the titanium, and the upper surface is filled with stainless steel weld metal. The entire weld is then covered by a titanium strip. This has the advantage of being strong and also the additional protection afforded by the stainless weld material, should a corrosive fluid make its way under the titanium overlay.

▶ **Advantages of Ti-Clad** — Notwithstanding the problems of welding Ti-clad, it is far easier to weld it in heavy gages than solid titanium plate. Titanium-clad is 25% cheaper than solid titanium which is about six times the cost of stainless steel. If lightness is a factor, solid titanium has the advantage, since steel is about twice as heavy.

New Manual on Hot-Dip Galvanized Products

A new publication of interest to the corrosion engineer is "Inspection Manual for Hot Dip Galvanized Products," a 34-p. booklet covering protective zinc coatings on products hot-dip-galvanized after fabrication. The manual describes the significant factors governing inspection, properties, specification and purchasing of hot-dip zinc coatings.

▶ **Standards**—To provide optimum protection, specific standards must be observed for both the base metal and the method of applying the zinc coating. This includes analysis of the ferrous metal, thickness and uniformity of the zinc coating, temperature and time of immersion into the zinc bath.

Illustrated with photographs, charts and graphs, the manual describes the galvanizing process, discussing such details as the metallurgical structure of zinc coatings, factors influencing adherence, effects of various conditions of the base metal, and the like.

High points of the booklet include a detailed check-list for inspectors' acceptance or rejection of items, and a section on product design and assembly in relation to hot-dip galvanizing. ASTM recommendations for zinc coating weights for different types of products are listed.

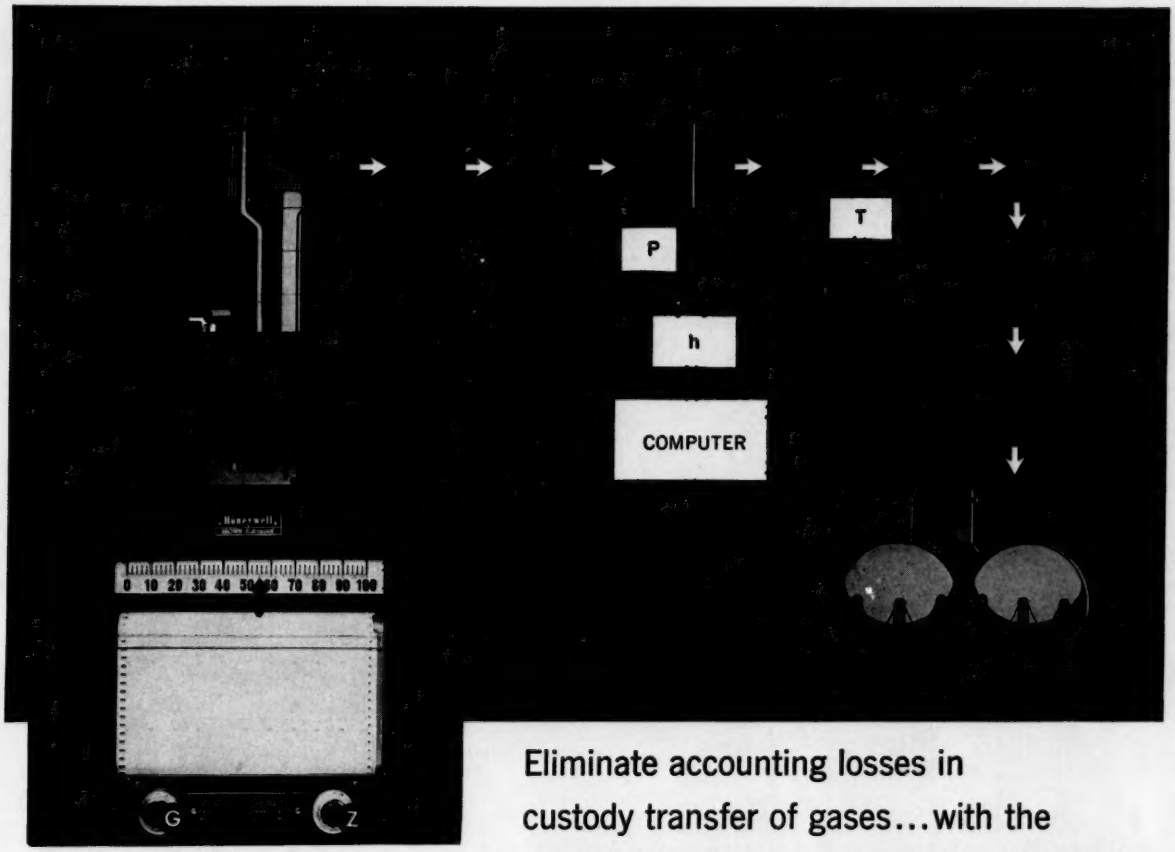
▶ **Where to Write**—For a free copy, write either American Zinc Institute, Inc., 292 Madison Ave., New York 17, N. Y., or the American Hot Dip Galvanizers Assn., Inc., 5225 Manning Pl., N.W., Washington 16, D. C.

Techniques for Repair Of Aluminum by Welding

"Aluminum Tank Repair" is a book recently published by Reynolds Metals Co. This 91-page, hardbound volume describes basic operations associated with repairs of both mobile and stationary tanks. It includes complete information on welding aluminum by both the gas tungsten-arc and gas metal-arc methods.

The book is profusely illustrated, contains numerous detailed drawings and tables. With this manual, most repair shops capable of handling steel tanks can effect repairs on aluminum tanks, although they must have the required (inert-gas shielded) welding equipment.

Address requests, on your business letterhead, to Reynolds Metals Co., Dept. PRD-45, Richmond 18, Va., for a free copy.



Eliminate accounting losses in custody transfer of gases...with the NEW HONEYWELL GAS FLOW COMPUTER

Here's how the Honeywell gas flow computer solves a gas flow equation:

$$Q = K\sqrt{\frac{hP}{TGZ}}$$

Where **Q** = mass rate of flow, scfh
h = differential pressure, inches of water
P = static pressure, psia
T = flowing temperature, °R, (°F + 460)
G = specific gravity
Z = super-compressibility
K = orifice flow constant

The *ElectriK Tel-O-Set* △P/I transmitter measures *h*; an absolute pressure transducer measures *P*; and a resistance thermometer bulb measures *T*. The analog computer multiplies *h* by *P* and divides by *T* . . . and sends a resultant millivoltage to the *ElectroniK* recorder. The recorder applies the correction factors G and Z, extracts the square root, and records the resultant mass flow Q.

When you're selling or buying gas, even a slight inaccuracy in flow measurement can mean the loss of many dollars. Prevent this loss with the accurate, all-electric gas flow computer. It measures, records, and totalizes *mass rate* of gas flow, automatically and continuously. Temperature and pressure variations are compensated for automatically—eliminating the inaccuracies of "averaging" and other methods of computation.

The gas flow computer does away with tedious, time-consuming calculations and the possibility of human error. In most applications, it will perform with accuracy of ±1%, and, under ideal conditions, with accuracy of ±½%. You can use this new computer to measure mass flow of such gases as ammonia, hydrogen, ethylene and other hydrocarbon gases, as well as hydrochloric acid gas. And you can easily link it to telemetering and remote control systems, supervisory control, data handling, and industrial process computers. Cost of the computer in most installations runs less than $4000.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

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CPI NEWS BRIEFS . . .

Continued from page 80

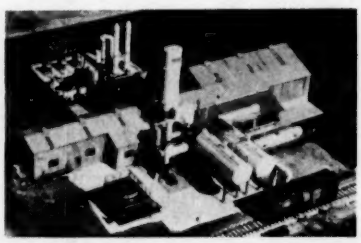
to state cost of the program. Schedule lists erection of a catalytic cracker and catalytic hydrogen-distillate treater, and expansion and modernization of laboratories. Construction is due to begin early this summer, with completion set for early 1962.

Goodyear Tire & Rubber Co. is spending $1 million to install a special finishing line at its Plioflex synthetic rubber facility in Houston. Designed and engineered by Brown & Root, Inc., unit when completed will "handle new types and special polymers."

Marquette Cement Co. plans a "complete rebuilding" of its Catskill, N. Y., cement plant on the Hudson River. Annual capacity for cement clinker will be hiked 50%, to 2.5 million bbl., as part of firm's $23.5-million expansion and modernization.

Clark-Schwebel Fiber Glass Corp. has begun weaving glass fabrics at its new, $3.5-million finishing plant in Anderson, S. C. Formed last July, the young company is concentrating on woven glass fabrics for reinforced-plastic pressure equipment.

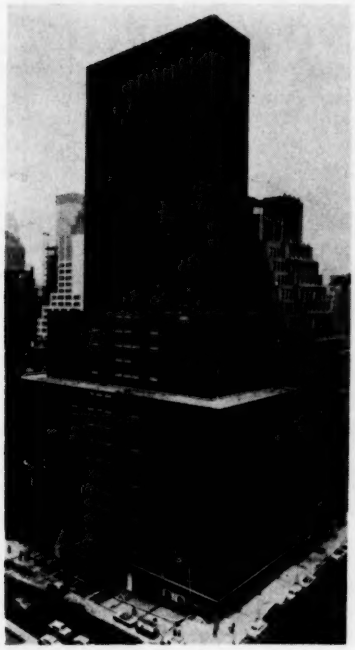
Gulf States Tube Corp., a subsidiary of Michigan Seamless Tube Co., has placed on stream in Rosenberg, Tex., a fully automated hot mill that cost $5 million, is said to turn out seamless steel tubing three times as fast as other units. Extruding 150 billets/hr., installation doubles firm's capacity at the site.



Air Reduction Sales Co. has opened two nearly identical air-

separation units on the Gulf Coast: one in Tampa, Fla. (pictured above), the other in Baton Rouge. Liquefied oxygen, nitrogen and argon are produced at a peak of 30 tons/day in each installation.

Offices



Chas. Pfizer & Co., Inc., announces the relocation of its New York headquarters into the above-pictured skyscraper, the Pfizer Building.

Pennsalt Chemicals Corp. has established a West Coast sales district, headquartered in San Mateo, Calif., to coordinate organic chemicals activity in Oregon, California and Washington.

Companies

American Cyanamid Co. will exchange an undisclosed chunk of its common stock for "substantially the entire business and assets" of Wasco Chemical Co., Inc.,

CPI NEWS BRIEFS . . .

including the stock of its subsidiaries. Headquartered in Cambridge, Mass., Wasco makes methyl methacrylate products at Sanford, Me.; Wichita, Kan.; Kearny, N. J.; and Toronto, Canada.

Crane Co. has purchased Midwest Piping Co., Inc., for approximately $18 million. Acquisition will be operated as Midwest Piping Div., at its existing facilities in Clifton, N. J.; Los Angeles; and Houston.

Firestone Tire & Rubber Co. plans to buy **Dayco Corp.'s** tire division. Sale will net Dayco enough to reduce by $1 million/yr. its annual interest charges on existing debts. Dayco's "substantial" holdings in Copolymer Rubber & Chemical Corp. are unaffected.

International

United Arab Republic's General Petroleum Authority contemplates a $75-million petrochemical complex at Suez to be fed 120,000 tons/yr. of light gasoline fractions from nearby government-owned refineries. Complete rundown of products scheduled for the project: 200,000 tons/yr. calcium nitrate; 5,000 tons/yr. polyvinyl chloride (4,000 of which are for export); 28,000 tons/yr. ethyl alcohol; 10,000 tons/yr. SBR rubber for captive manufacturing into 1 million auto tires; 17,400 tons/yr. glycerol for export; 3,000 tons/yr. polystyrene (including 2,000 for export); 6,000 tons/yr. low-pressure polyethylene; 5,000 tons/yr. benzene or 9,000 tons/yr. toluene; 6,000 tons/yr. dodecyl benzene; and 28,000 tons/yr. elemental sulfur for captive conversion to sulfuric acid and carbon disulfide.

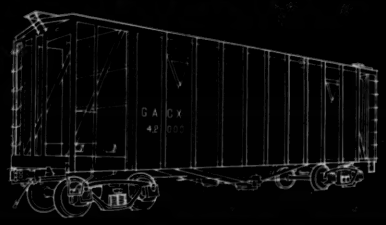
Israel proposes joint American-Israeli-Latin American investment of $16 million in a petrochemicals complex on Haifa Bay, sparked by completion of a 257-mi. pipeline that neatly routes 2 million tons/yr. of crude from Eilat, on the Red Sea, around the perenially troubled Suez Canal to Haifa on

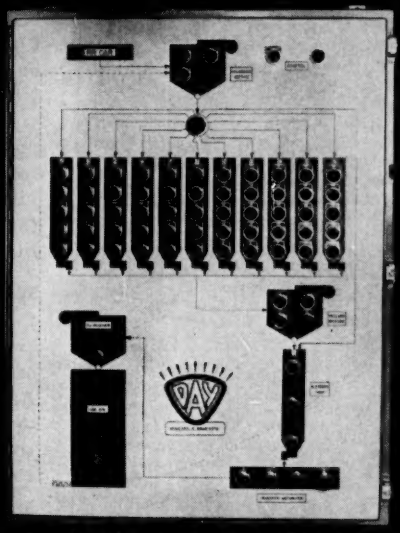
High density pneumatic conveying system for unloading polyethylene pellets from railcar. After piping connections are made, dual-purpose DAY "RJ" receiver, shown right in photo, "pulls" product from railcar and "pushes" it to storage tanks or manufacturing process.

PUSH A BUTTON

START

UNLOAD A RAILCAR





DAY Control panel — your most efficient link between railcar and plant, storage or process.

Save manpower, time and money unloading railcars with DAY *air-line* pneumatic conveying systems. They provide a sanitary, low cost way to unload, transport in-plant, mix, dry, cool or load any type of dry material. DAY *air-line* pneumatic conveying systems are pneumatically conveying close to 200 different products. Take advantage of this DAY experience. Discuss your pneumatic conveying and plant storage equipment requirements with DAY. Only DAY offers a complete service, including: *engineering, fabricating* and *installation* of *everything* (including bulk storage tanks) needed for efficient, economical systems.

FREE bulletin describes all types of pneumatic conveying systems. It tells how you can make substantial savings 9 ways and improve plant efficiency 6 ways with DAY *air-line* pneumatic conveying systems.

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CPI NEWS BRIEFS . . .

the Mediterranean. Petrochemicals venture would make 15,000 tons/yr. ethylene; 6,000 tons/yr. polyethylene; 10 million tons/yr. carbon black; 6,000 tons/yr. dodecyl benzene.

Australia: Shell Refining (Australia), Pty. Ltd., has announced the continent's third lube-oil project. To be built at Shell's Goolong refinery, near Melbourne, the $13.5-million installation will turn out 23 million gals./yr. from a labyrinth of heavy equipment, including de-waxer, propane de-asphalter, high-vacuum unit, furfural extractor. Present Australian lube-oil consumption is estimated to be 66 million gals./yr., 60 million of which are imported.

West Germany: Bobina Faserwerke GmbH., a new Bavarian firm created jointly by Celanese Corp. of America and Farbwerke Hoechst A.G., will produce 32 million lb./yr. of nytril fiber in a plant tentatively scheduled for completion in 1962 at Bobingen, Bavaria, in the south of West Germany. Hoechst will supply the raw materials; Celanese, the know-how. Product will be trademarked Travis, for European sale, although the same fiber has been marketed by Celanese in the States as Darvan for over a year.

Japan: Idemitsu Kosan has requested government go-ahead to build a 100,000-ton/yr. ethylene plant at Tokuyama, in southern Honshu. Due on stream in 1962, facility would cost $36 million (including $4.4 million to Universal Oil Products for process license), bring Japan's total ethylene capacity to more than 392,000 tons/yr.

East Germany, the world's sixth largest chemicals-producing country, has ended a 21-year-old blackout on technical information. Under the terms of an agreement signed by Britain's Humphreys & Glasgow Ltd. with East Germany's state-owned LIMEX, some 60 Iron Curtain processes are now available for licensing through the former firm. Sample routes were

CPI NEWS BRIEFS . . .

uncovered to acrylonitrile, caprolactam, acrylics, emulsion resins, synthetic fibers, vinyls.

India: Naharkatiya oil-well area in Assam state, northeast India, is the proposed site of a huge, sprawling chemicals complex for which over $60 million has already been committed by state, private domestic, and foreign investors. Still in the planning stage, but due on stream in 1964-5, are: a 4,000-ton/yr., $8-million polyethylene unit; $2-million carbon-black furnace; 20,000-ton/yr., $30-million synthetic rubber factory; 50,000-ton/yr. chemical fertilizer plant; and a $20-million thermal power station. Rumanian and Soviet engineers in Assam and Bihar states, respectively, have already begun work on refineries that annually will process a total of 2.75 million tons of area crude, beginning in 1962-3.

Great Britain's first petrochemical phthalic anhydride will be produced by Grange Chemicals, Ltd., a joint subsidiary of British Hydrocarbon Chemicals, Ltd., and California Chemical Co. According to unconfirmed reports, the proposed 15,000-long ton/yr. plant will be built at Grangemouth, Scotland, although orthoxylene feed will come from an aromatics unit currently under construction at the Isle of Grain refinery in Kent, southern England.

Japan: Asahi Chemical Industries Co. has licensed the Soviet route to Silikalteiit, a construction insulation made of sand and lime. Signed in Moscow with the Russian Sundry Goods Export Corp., contract calls for Japanese payment of $3 million in ten years.

Rumania plans to produce 50,000 metric tons/yr. of raw aluminum, starting in 1964, at a mill to be built at Slatina, Arges Province. Power would come from a hydroelectric station proposed for the Arges River; but blueprinted output of this power plant is reported to be only 400 million kwh., while the aluminum mill is estimated to

require 720 million kwh. to produce the aluminum tonnage that Rumania quotes for it.

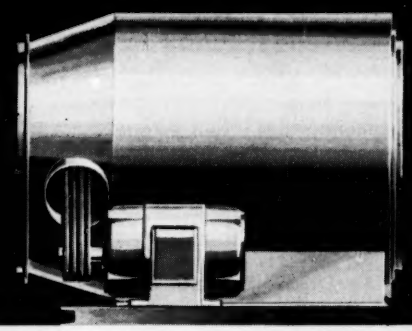
West Germany: Baden Wurttemberg Nuclear Power Plant Planning Assn., an amalgam of 13 utilities in the Baden-Wurttemberg area, has awarded Atomics International Div. of North American Aviation, Inc., the preliminary-design contract for a 150,000-kw. organic-reactor nuclear power plant. Reactor will take a year to design.

Czechoslovakia: Polytechna, the Czech state trade agency, has purchased major process licenses from three European firms: (1) Imperial Chemical Industries's route to polyester fiber; (2) Badische Anilin und Soda Fabrik's benzene hydrogenation-refining process; (3) Montecatini's ammonia, acetylene, and pressure-fission of methane techniques. Another agreement, termed "management license," was signed with an undisclosed Liechtenstein firm for a glass-melting electric booster.

Mexico: Negromex, S.A., is building a $4-million plant at Salamanca, 200 mi. northwest of Mexico City, to make 33 million lb./yr. of carbon black. Licensed from Phillips Petroleum, process will feed on stock from one of several Pemex refineries in the area.

Japan: General Electric Japan, Ltd., a wholly owned subsidiary of GE, expects to place the Far East's first nuclear power plant on stream in early 1963. A demonstration unit, the direct-cycle, boiling-water reactor is designed to produce 12,500 kw. from enriched uranium dioxide at Tokai Mura, about 50 mi. northeast of Tokyo, for the Japan Atomic Energy Research Institute.

India: Union Carbide (India) Ltd.'s $9 million polyethylene plant on Trombay Island, near Bombay, is on stream with a rated capacity of 15 million lb./yr. Facility is second of its kind in the country; first one, owned by the domestic Alkali & Chemical



INSTALLATION: S. D. WARREN COMPANY, CUMBERLAND MILLS, MAINE SYSTEM DESIGNER AND BUILDER: J. O. ROSS ENGINEERING, DIVISION OF MIDLAND-ROSS CORP.

Problem: Tight squeeze in a paper mill. Solution: CENTRILINE fans

In an area limited by low headroom, S. D. Warren Company, Cumberland Mills, Maine, solved a critical space problem by installing CENTRILINE® fans under their new coated paper dryer, where conventional centrifugal fans couldn't possibly fit.

Three CENTRILINE fans feed the forced-air drying system in the new machine. These new in-line, Airfoil, centrifugal fans from Westinghouse take up less than half the installed space of conventional centrifugal fans...yet they give comparable performance. J. O. Ross, designers and builders of the equipment, found that under-oven location of the CENTRILINE fans saves floor space...permits less expensive duct runs, easier maintenance, greater accessibility to fan inlet vane controls that regulate air volume. Quiet and efficient operation is assured by a Westinghouse exclusive: the Airfoil bladed centrifugal wheel.

You can save space, cut installation costs and assure quietness with CENTRILINE. Mail coupon now.

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CPI NEWS BRIEFS . . .

Corp., operates at Ridhra, near Calcutta. Trombay unit will draw its feed—about 3 million gal./yr. of alcohol—from a government-owned distillery 200 mi. from Bombay.

France: Polymer Corp. SAF, a newly formed subsidiary of Polymer Corp., Ltd., Sarnia, Ont., has awarded a $12 million contract to Badger S.àR.L., Paris, for the construction of a 10,000-ton/yr. specialty rubber plant near Strasbourg. Feed will come from several refineries now under construction in Alsace near the Marseilles-Karlsruhe pipeline. Construction will begin this summer, with a completion date late in 1962.

Vietnam: Bay area of Camranh, 180 mi. northwest of Saigon, has been selected as the site for a planned 22,000-bbl./day petroleum refinery. Government is reviewing two offers for the $15-million proposed facility, one by Shell Oil and Standard Vacuum, the other from Phillips Petroleum and U. S. Summit Industrial Corp. Vietnam wants to develop Camranh into a spawling chemicals (fertilizer, aluminum, cement) and industrial complex.

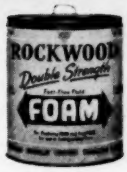
Central African Federation: Aluminum Industries A.G., headquartered in Zurich, is negotiating a proposal with the Central African government for a $10 million aluminum smelting facility somewhere in the interior (probably close to the cheap power supply of Kariba Hydroelectric Project on River Zambesi). Since the Federation's present bauxite production is insufficient to support such an enterprise, discussions are centering on the import of reserves from Guinea.

Japan: Polyurea fiber named Yurilon, said to be 10% lighter than nylon or acrylic fibers, is being made from rice-bran oil, urea and ammonia by Toyo Koatsu in a new plant just on stream in Hokkaido, the northernmost island of Japan. Unit turns out 1 ton/day, soon will be stepped up to 10 tons/day.

The moment they get there . . .

They put out fires faster!

Rockwood FOAM liquid provides a smothering, fine-bubble blanket over flammable liquid fires. Rockwood's FW Eductor introduces FOAM liquid into water streams.



You get faster extinguishing action when refinery and chemical fire trucks are equipped with Rockwood FOAM apparatus

Once a Rockwood-equipped truck reaches the fire, its FOAM system starts working — enabling fire fighters to hit harder and finish faster.

That goes for all the trucks shown here — just a few of the large number that carry FOAM equipment, developed by Rockwood for specialized fire fighting service at refineries and chemical plants throughout the country.

To these industries Rockwood offers the most complete line of specially engineered systems, devices and accessories for FOAM fire trucks — as well as FOAM systems for protecting refinery and chemical tanks.

Rockwood makes the world's most complete line of specialty turret nozzles. Providing the power so vitally needed at flammable liquid fires, these nozzles can deliver up to 10,000 GPM of expanded FOAM. All are adjustable for handling a solid FOAM stream, FogFOAM, WaterFOG or solid water stream. For details on the many Rockwood products that have proved their exceptional ability in refinery and chemical fires send for illustrated booklet. Rockwood Sprinkler Company, Portable Fire Protection Department, 531 Harlow St., Worcester 5, Massachusetts. Distributors in all principal cities. Rockwood Sprinkler Company, A Division of The Gamewell Company, A Subsidiary of E. W. Bliss Company. *Rockwood engineers water . . . to cut fire losses.*

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Convention Calendar

May

22-24. American Society for Quality Control, Annual Convention and Exhibition, Sheraton Hotel, Philadelphia.

22-25. American Society of Mechanical Engineers, Design Engineering Show, Cobo Hall, Detroit, Mich.

22-26. American Society of Tool and Manufacturing Engineers, 1961 Engineering Conference and Tool Show, New York Coliseum, New York, N. Y.

23-25. Office of Naval Research, Information Systems Branch, Symposium on Large Capacity Memory Techniques for Computing Systems, Dept. of the Interior, Washington, D. C.

June

4-8. American Nuclear Society, Annual Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

5-9. Society of the Plastics Industry, National Plastics Exposition and Conference, New York Coliseum, and Commodore Hotel, New York, N. Y.

5-16. Johns Hopkins University, Operations Research and Systems Engineering Course, Baltimore, Md.

6-8. Instrument Society of America, Summer Instrument-Automation Conference, Royal York Hotel and Queen Elizabeth Hall, Toronto, Canada.

7-9. Canadian Pulp and Paper Assn., 1961 Summer Meeting, Saranac Inn, Saranac, N. Y.

8-10. Manufacturing Chemists' Assn., 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

9-17. 1961 ACHEMA Chemical Engineering Congress and Exposition, Frankfurt am Main, Germany.

11-14. American Society of Mechanical Engineers, Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

11-15. Air Pollution Control Assn., 54th Annual Meeting, Hotel Commodore, New York, N. Y.

11-23. The Pennsylvania State University, Engineering Seminar on Solid State Mechanics, University Park, Pa.

12-16. Air Pollution Control Assn., Annual Meeting, Hotel Commodore, New York, N. Y.

14-16. American Society of Mechanical Engineers, Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

16-25. Europlastica, International Plastics Exhibition, Ghent, Belgium.

19-21. University of Southern California, Heat Transfer and Fluid Mechanics Institute, Los Angeles, Calif.

19-23. Massachusetts Institute of Technology, Technology of Reinforced Plastics Course, Cambridge, Mass.

19-30. The University of Michigan, Summer Conference on Systems Engineering, Ann Arbor, Mich.

20-26. European Federation of Chemical Engineering, Third Congress, London, England.

21-1. Interplas 61. Sixth International Plastics Exhibition and Convention, Olympia, London, England.

21-23. American Assn. of Cost Engineers, Annual Meeting, Somerset Hotel, Boston, Mass.

22-25. Society of Women Engineers, National Convention, Statler-Hilton Hotel, Boston, Mass.

23-25. Compressed Gas Assn., Inc., 48th Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

25-30. American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

26-30. American Society for Engineering Education, Annual Meeting, University of Kentucky, Lexington, Ky.

26-7. Massachusetts Institute of Technology, Summer Program on Dynamics and Control of Chemical Engineering Processes, Cambridge, Mass.

28-30. American Institute of Chemical Engineers, Instrument Society of America, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Institute of Radio Engineers, Joint Automatic Control Conference, University of Colorado, Boulder, Colo.

Later

October 11-12. CHEMICAL ENGINEERING and Armour Research Foundation, Conference on the New Trends in Chemistry, Chicago, Ill.

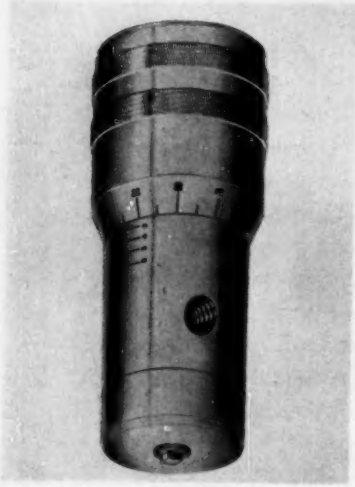
November 27-December 1. 28th Exposition of the Chemical Industries, New York Coliseum, New York, N. Y.

NEW EQUIPMENT . . .

(Continued from page 92)

in one location, carry it to another, raise and/or tilt it, and empty its contents.

Unit has the advantage of being able to work in small areas of minimum headroom, being easily maneuverable on 8-in. sparkproof wheels. It comes equipped with either an a.c. or a battery-operated power pack. — **Sterling Fleischman Co., Broomall, Pa. 92D**



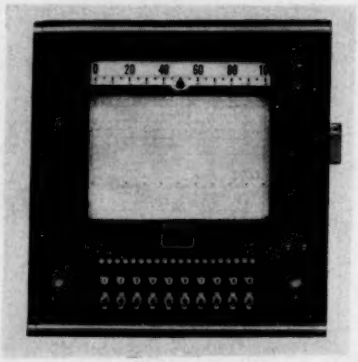
Pressure, flow regulators

Units maintain pressure and flow despite varying line pressure.

Controlling pressure within ±0.25%, a regulator with a fingertip micrometer adjusts instantly, can be reset with a normal repeatability of ±0.5%. It is said to maintain a precise outlet pressure with varying inlet pressure or flow for supply pressures to 150 psi.

A pressure-balanced, floating spool instantly corrects for changes, valve design eliminating diaphragms and valve seats. Unit can not be used as a shutoff valve, thereby retains maximum sensitivity with minimum wear. The regulator has downstream pressure loss compensation that automatically corrects for line losses.

For flow regulation, a companion unit controls gas flow from 5 to 300 std. cu. ft./hr., maintains flow constant despite fluctuations in inlet and outlet pressure.—**Circle Seal Products Co., Inc., Pasadena, Calif.—Pressure regulator, 212A; Flow regulator, 212B.**



Alarm scanner

Instrument activates recorder and alarm when conditions deviate.

Checking a point every second, a transistorized alarm scanner watches 200 measured variables, springs into action if it spots any deviation from normal settings.

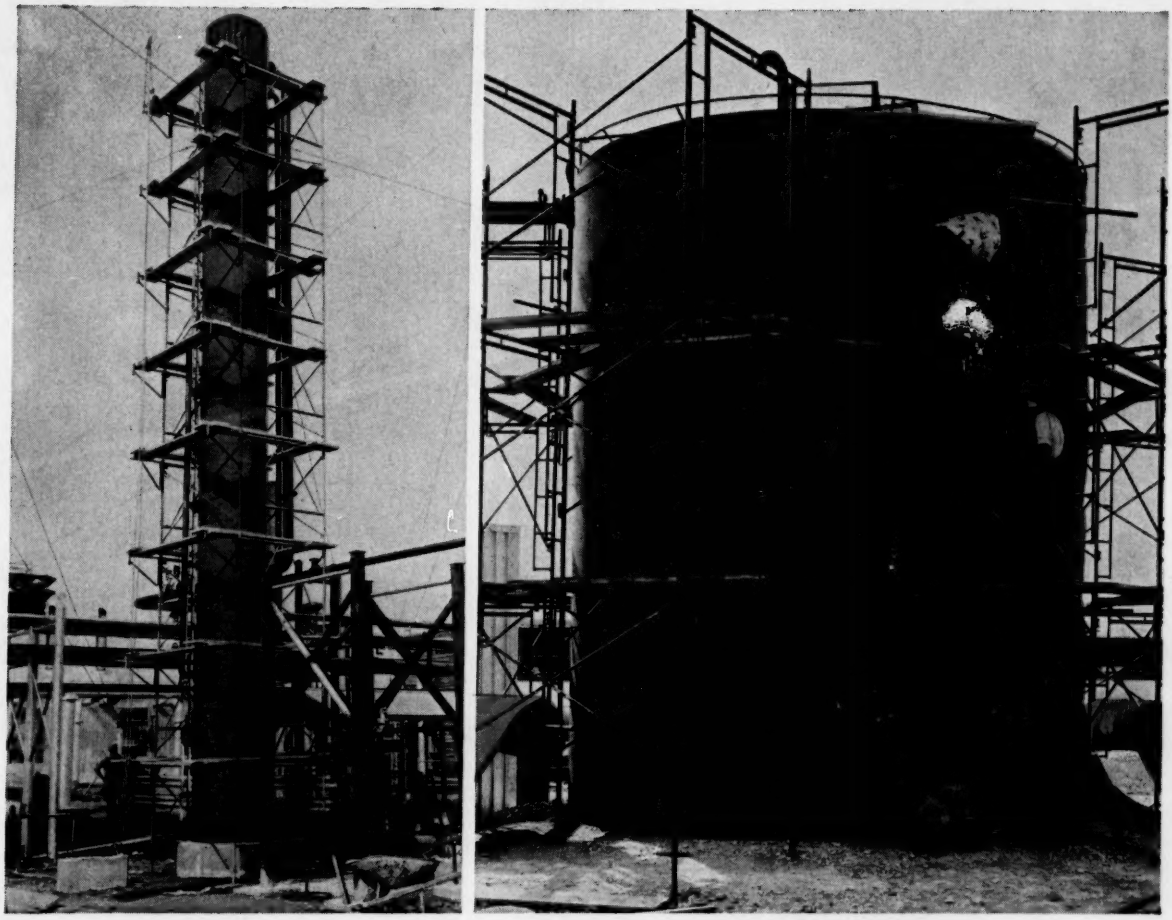
Upon discovery of an abnormal situation, the device activates a recorder and an alarm lamp and energizes any external alarm system. The recorder identifies the variable and makes a record of its abnormal condition. Upon completion of its alarm functions, the instrument returns to normal scanning.

Long recorder life is promised by the manufacturer since that part of the unit is energized only on discovery of an alarm condition. Lamp banks on the face of the device allow following the cycle point by point, or manually adjusting to single-point scanning or recording. — **The Bristol Co., Waterbury, Conn. 212C**

Bulk-material loader

Unit throws free-flowing solids any direction in a compact stream.

Called Speed Loader, a device consisting of an endless rubber conveyor belt can throw up to 8,600 cu. ft./hr. of free-flowing



The fastest, most economical way to insulate tanks and towers: Ultralite® Glass Fiber Blankets

NO SPECIAL BANDING OR STRAPPING—Made exclusively of long, strong textile-type glass fibers that have ten times the tensile strength of steel fibers of the same diameter, Ultralite can easily support many times its own weight without special bands or straps.

FEWER MAN-HOURS FOR INSTALLATION — With continuous blankets up to 10′ wide you can cover, in one quick operation, a 10′ wide area from the top to the bottom of the tank. (Compare this to the man-hours it takes with blocks, boards or other fiber glass products in small sheets!) Ultralite is lightweight and easy to handle—1000 sq. ft. of 2″ Ultralite #75 weighs only 125 lbs.

OFTEN REQUIRES LESS THICKNESS — Ultralite's low "k" factor (.27 at 75° m.) allows you to save in another way. It takes less thickness of Ultralite to provide the same overall insulating efficiency of many other insulation materials. And with 10′ wide blankets there are fewer joints —a primary source of heat loss or gain with other insulation materials.

PERMANENT AS GLASS ITSELF — Ultralite's glass fiber composition does not rot, corrode, support mildew or vermin, or otherwise deteriorate. Because of its unique ruggedness, it is virtually immune to damage during and after installation. In fact, Ultralite can even be reused with no loss of thermal efficiency or permanence.

WRITE FOR COMPLETE INFORMATION, INCLUDING DETAILED APPLICATION METHODS, TODAY.

GUSTIN-BACON *Manufacturing Company* GUSTIN® gb BACON

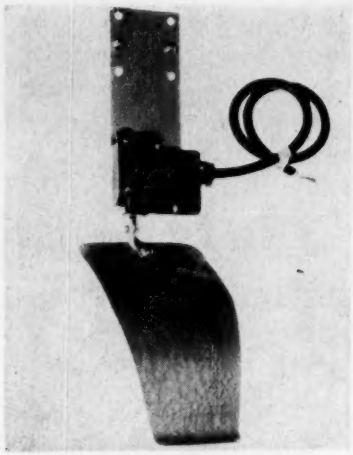
252 W. 10th St., Kansas City, Mo.

Thermal and acoustical glass fiber insulations . . . Molded glass fiber pipe insulation . . . Couplings and fittings for plain and grooved end pipe

bulk material in any direction from a given point. The belt's throwing section is held in a concave curved position by two large disk idlers placed on the outer edges of the belt.

Material is fed onto the belt between the idlers. Attaining belt speed, it is thrown in a stream over the front pulley of the device.

With a throwing radius of 50 ft., the Speed Loader can form a pile of material up to 25 ft. high. It can be used to load boxcars, trucks or ships, fill storage buildings and areas, stockpile materials, and distribute or rotate material for aeration. It is available in 5 models for specific applications. — **Fort Worth Steel & Machinery Co., Fort Worth, Tex.** **212D**



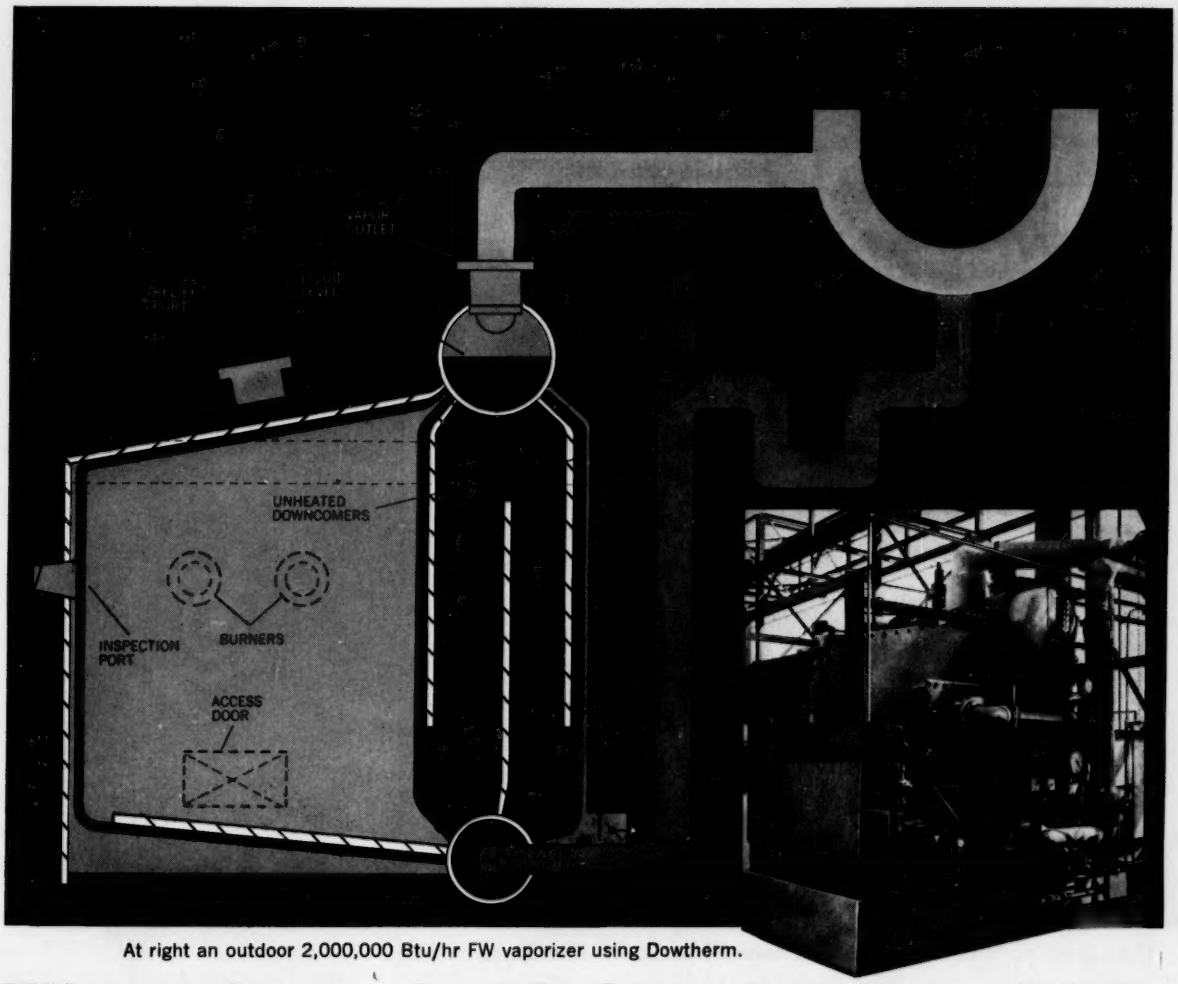
Level-control switch

Hanging paddle reacts to solids, cuts off material flow.

An automatic level switch for bins, feeders and chutes consists simply of a hanging paddle and a switch mechanism. When material builds up in the controlled area, the paddle is lifted until it reaches an angle of about 40 deg., when it trips the switch to shut off the inflowing material.

Completely enclosed, moisture- and splashproof, the switch is attached to a sheet metal bracket that may be formed to facilitate mounting on any bulk tank or bin.

Since a differential travel of 40



At right an outdoor 2,000,000 Btu/hr FW vaporizer using Dowtherm.

FW vaporizers...less to buy...less to maintain

By surveying and understanding your entire process, Foster Wheeler engineers are able to tailor your vaporizer and its auxiliaries exactly to your needs. By thus avoiding over- and under-design, you are assured minimum first cost consistent with dependable economic performance.

FW natural circulation vaporizers and their adaptability to gravity return systems mean fewer moving parts, lower power consumption, reduced pump cost and maintenance, and greater accessibility. Such units also use a smaller quantity of valuable heating medium.

In addition, FW vaporizers offer unusually sensitive heat control by eliminating flash-down to achieve precise final temperatures. This means instant response to temperature variation and reduced degradation of the heating medium . . . protecting your investment in it.

FW vaporizers do all of this with fewer control devices and less auxiliary equipment than recommended with other vaporizers. With less to buy and maintain, both first cost and operating overhead are held down. By surveying and understanding your entire process the most practical piping arrangements can be made to allow for optimum heat transfer as well as operator convenience.

Over the last 26 years Foster Wheeler has supplied over 700 organic heating systems for every application and capacity, from the smallest on up to single units delivering in excess of 50,000,000 Btu/hr. Get full benefit from this broad experience by discussing your requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

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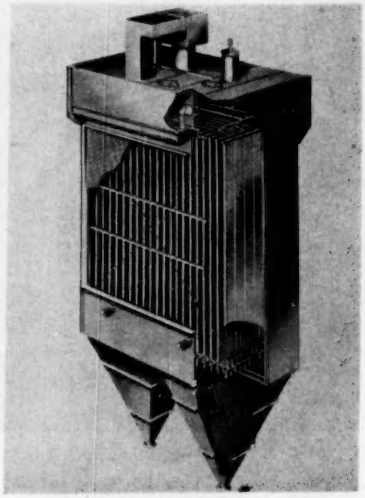
deg. is needed to actuate the switch from off to on (and vice versa), considerable change in feed level is needed to operate the switch. This eliminates short running time and false starts, thus saving power and prolonging the life of the moving parts.

The unit can be equipped with a float for controlling liquid level. **—Hawkeye Steel Products, Inc., Waterloo, Iowa. 214A**



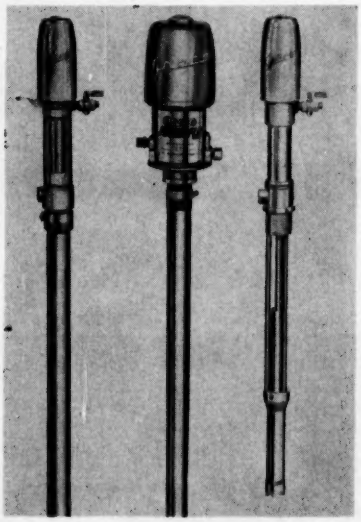
Dust collector

Electrostatic device achieves high efficiency with flat plates.

Under any dust-collection application, this precipitator is said to attain high efficiency by flat, vertical design of its collector plates. Unique "pockets" trap and hold collected dust, thus reducing chance of re-entrainment. Non-welded, roll-formed plate construction minimized warping, which also contributes to efficiency.

Housing is heavy-gage steel plate. Four types of high-voltage rectifiers are available: silicon, selenium, vacuum tube, mechanical. A choice of control mechanism is also available: (1) saturable reactor (a variable-inducance d.c. control), (2) monocyclic network (a constant-voltage to constant-current transforming device), (3) variable resistor.

Any of the three control options can be automated by all-transistor circuitry. Fully automatic design is reported to work best with saturable reactor.—**American Radiator & Standard Sanitary Corp., Detroit.** 216A



Air-operated pump

Stainless steel unit will handle a wide range of liquid viscosities.

Air operated, a new stainless steel pump is designed for high-volume transfer of chemicals, cosmetics, drugs, acids, food, dyes and other hard-to-handle materials.

The lightweight, double-acting Fast Flo dispenses fluid directly from drums or open containers. For high-volume, continuous-duty pumping of light or heavy fluids, the Monark will handle anything for isopropyl alcohol to peanut butter.—**Gray Co., Inc., Minnesota.** 217A

Hose, pipeline filter

Designed for flows to 720 gpm, unit screens out 10-micron particles.

A stainless steel cone-shaped wire-cloth filter element provides effective 10-micron filtration for nozzle-end hose and pipeline installations. Particularly effective

in collecting construction residue during startup operations, it also serves as a guard to critical filters during normal operation.

Pressure drop through the unit ranges from 3 to 7 psi.; with contaminant buildup reducing the flow of fluid, the filter safely handles a pressure drop of up to 150 psi. It is cleaned in place by backwashing with clean product.

Dubbed Turbomonitor, it comes in lengths of 10½, 14½ and 17½ in., accommodating flow rates at ambient temperature of 300, 360 and 720 gpm., respectively.—**Purolator Products, Inc., Rahway, N. J. 217B**

Briefs

Butterfly valve has snap-in replaceable rubber liner with self-aligning shaft holes to speed reassembly. Sized 2-12-in., unit works on vacuum, or differential pressures to 150 psi. Depending on liner material used, temperature range is −60 to +400 F.—**Continental Equipment Co., Coraopolis, Pa. 219A**

Flexible plastic pipe insulation, available in tube or sheet form, serves from subzero to 220 F. Tubes snap over new or existing piping, saving installation time. Sheets may be fabricated into coverings for pipes larger than 3 in. Material is said to transmit little water vapor.—**Gustin-Bacon Mfg. Co., Kansas City, Mo. 219B**

Polypropylene filter fabrics have good resilience and abrasion resistance, are particularly suited for hot, corrosive applications involving separation of gelatinous precipitates or abrasive dusts. Product is available as fabricated filter elements or yard goods.—**Technical Fabricators, Inc., Nutley, N. J. 219C**

Portable rescue kit contains a resuscitator and a foot-operated suction pump. Instantly available because it requires no electricity or other connections, the pump starts suction with the first step,

clearing the mouth and throat of any liquid. Unit delivers 700 cc. of air to the lungs, which is more than can be delivered by mouth-to-mouth breathing but less than the capacity of an adult's lungs.—**American Optical Co., Southbridge, Mass.** **219D**

Central compression unit delivers up to 150 scfm. of maximum purity air, helium, nitrogen or other gases at 3,500 to 12,000 psi. Skid-mounted, the complete system includes dehydrator, oil removal equipment, control panel and 4-stage, 8-cylinder air-cooled compressor.—**Cardair, Div. of Marmon-Herrington Co., Inc., Chicago.** **220A**

Flexible joint provides gimbal and swivel movement for 2 to 12-in. pipes at up to 200 psi. within the temperature range of −325 to +275 F. Particularly suited for handling liquefied gases, the joint is used for pipe expansion or contraction joints, for flexible metal arms, and as swivels.—**Barco Mfg. Co., Barrington, Ill.** **220B**

Equipment Cost Indexes . . .

	Dec. 1960	Mar. 1961
Industry		
Avg. of all	237.3	237.2
Process Industries		
Cement mfg.	231.6	231.3
Chemical	238.1	238.0
Clay products	225.1	224.8
Glass mfg.	224.8	224.7
Paint mfg.	229.4	229.7
Paper mfg.	229.4	229.3
Petroleum ind.	234.3	234.7
Rubber ind.	237.1	237.6
Process ind. avg.	236.1	235.9
Related Industries		
Elec. Power equip.	238.3	237.9
Mining, milling	239.5	239.4
Refrigerating	268.0	268.5
Steam power	224.5	224.9

Compiled quarterly by Marshall and Stevens, Los Angeles, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6, for method of obtaining index numbers; Mar. 6, 1961, pp. 115-116, for annual averages since 1913.

Technical Bookshelf

THIS IS THERMOELECTRICITY

THERMOELECTRIC MATERIALS AND DEVICES. ED. BY I. B. CADOFF AND E. MILLER REINHOLD. 358 PAGES. $9.75.

Reviewed by Ernest J. Henley, Stevens Institute, Hoboken, N. J.

Outgrowth of a one-week introductory course in thermoelectricity given at NYU, Cadoff and Miller's book is a somewhat unique publishing venture—an introductory textbook written by 20 authors.

Considering the potpourri that might have resulted had the editorial work been less skillfully handled, the book is well organized, and the editors are to be particularly praised for using consistent nomenclature.

First section is devoted to the theory of thermoelectric processes and circuits. This is followed by sections on materials and applications. The topics flow in logical sequence, and one is able to get a good over-all picture of the field.

As is to be expected, coverage and level of sophistication varies considerably from chapter to chapter. The specialist will be disappointed in the lack of literature references throughout most of the work.

An impending widespread use of thermoelectric devices for power generation and refrigeration makes this a timely and useful volume, however. Chemists and chemical engineers desiring a good overall status of the field compendium would be well advised to obtain a copy; specialists will also find it worthy of attention.

In Rapid Review

Chemical Engineering Practice. Vol. 10: ancillary services. Ed. by H. W. Cremer and S. B. Watkins. Academic Press Inc., New York. 606 pages. $19.50. Tenth in a set of 12 volumes, this heavily diagrammed and tabulated reference work presents the basics of currently onstream processes and equipment under these headings: "Fuels—Solid, Liquid and Gaseous," "Combustion Systems for Solid, Liquid and Gaseous Fuels," "Steam," "Electrical Installations," "Water Supplies," Effluent Treatment and Disposal." "Methodical and thorough (index alone covers 20 pages) text in-

corporates definitions, equations, charts and text in a college coursebook format.

Source Book of the New Plastics. By H. R. Simonds. Reinhold. 310 pages. $8.95. A new series of yearbooks on plastics is now keeping abreast of the industry's rapid flow of new materials and processes. Rounding up 1960's developments in a wieldy 310 pages, Vol. 2 of the series was published in February. It should be of most help to readers who want to know specifically what products "X" company developed last year. A good two-thirds of the book is devoted to a section called Producer's New Materials, in which plastics manufacturers—in this volume, 69 of them—line out their own year's contribution to the industry's products. This type of presentation tends to dilute and somewhat obscure the identity of the most significant contributions in a welter of refinements, modifications and repetitions.

And Also Received

Corporate Diagrams and Administrative Personnel of the Chemical Industry. March 1961. 4th annual ed. Looseleaf-bound in this very useful volume of 95 spread-pages are the organizational charts of 51 major CPI firms (from Amchem Products, Inc., to U. S. Rubber Co.), and the names and positions of corporate management personnel for 42 others (from Air Reduction Co. to Wyandotte Chemicals Co.). All but four of the line-diagrams are depicted on the same size paper (11 x 17 in.); hence, greater depth is found in the organization ladder of a small company than in that of a large. The four firms granted wider sheets (18 x 24 in.) are Du Pont, Celanese, W. R. Grace, and U. S. Borax & Chemical. A September supplement will bring the listings up to date. Single copy (including supplement) costs $20. Write: Chemical Economic Services, P. O. Box 468, Princeton, N. J.

Report of the International Commission on Radiological Units and Measurements (ICRU) 1959. Handbook 78. Supersedes Handbook 62. Issued Jan. 16, 1961. A 90-page booklet of definitions, diagrams and discussions in the field of radiation, aimed at establishing standards of jargon, dosimetry and measurement units. 65¢. Write:

TECHNICAL BOOKSHELF . . .

National Bureau of Standards, Office of Technical Information, Wash. 25, D. C.

AWS Definitions: Welding and Cutting. Revised 1961. The dictionary that "does for welding what Webster does for the English language" has been revised for the first time in 12 years. In 59 pages of definitions, tables, diagrams, charts, and one color plate titled "Master Chart of Welding Processes," the American Welding Society defines and illustrates such terms as "button," "horn," "knee," "multiple-impulse welding," "induction brazing," "percussion welding." $2. Write: American Welding Society, 33 West 39th St., New York 18, N. Y.

Journal of Chemical Documentation. Vol. I, No. 1. Published semiannually by American Chemical Society. In its maiden issue, the journal boasts 96 pages, 24 papers on such subjects as "French Organic Nomenclature," "Detecting Corresponding Patents from Different Countries," "Information Theory and Other Quantitative Factors in Code Design for Document Card Systems." Annual subscription: $7 to ACS members, $10 to nonmembers (excluding postal). Single numbers: $5.50. Write American Chemical Society, Attn. Mr. R. H. Belknap, 1155 Sixteenth St., N.W., Washington 6, D. C.

Student Financial Aid in Higher Education. W. C. Eells and E. V. Hollis. An annotated 87-page bibliography of published materials on scholarships, fellowships, loan funds, and part-time employment. Price: 35¢. Write: U. S. Govt. Printing Office, Washington, D. C.

Food and Color Additives Directory. 5 vols. Published by Hazelton Laboratories, Inc. and Information for Industry, Inc. Aimed at keeping subscribers up to date on all petitions to, and regulations by, the FDA on food and color additives, this looseleaf directory initially contains approximately 7,000 Federal Register references, arranged alphabetically by chemi-

cal. Monthly thereafter, publishers will replace and supplement the original pages to cover new regulations. $150 for the initial directory, $150 annually for the monthly revisions. Write: Hazelton Laboratories, Box 30, Falls Church, Va.

Patent Service. Unique plan offers both the complete text and an abstract of every domestic and foreign patent in one or all of four fields, at various annual subscription rates: Detergents & Emulsifiers ($250), Soaps & Glycerin ($200), Fatty Acids & Their Derivatives ($300), Oils & Fats ($250). Copies of original patents, translated if necessary, and edge-punched 5×8-in. abstract cards are mailed semimonthly to subscribers. Special discounts and multiple-subscription rates available. Write: John W. McCutcheon, Inc., 236 Mt. Kemble Ave., Morristown, N. J.

More New Books

Pulp and Paper: chemistry and chemical technology. 2nd ed. Vol. 3: paper testing and converting. By J. P. Casey. Interscience. Pages 1251-2113. $29.50.

Crystallization. By J. W. Mullin. Butterworths, Wash., D. C. 268 pages. $11.

Gas Chromatography Abstracts. Ed. by C. E. H. Knapman. Butterworths. 1958 volume: 215 pages, $8.50; 1959 volume: 122 pages, $8.50.

Turning Points in Physics. By various authors. Harper Torchbooks. 192 pages. $1.45.

Causality and Chance in Modern Physics. By D. Bohm. Harper Torchbooks. 170 pages. $1.35.

A Modern Introduction to Logic. (1931). By L. S. Stebbing. Harper Torchbooks. 525 pages. $2.75

Boilers: types, characteristics and functions. By C. D. Shields. F. W. Dodge Corp., New York. 559 pages. $15.

Water—the mirror of science. By L. S. Davis and J. A. Day. Doubleday Anchor (paperback, original). 195 pages. 95¢.

Rare Metals Handbook. 2nd ed. Ed. by C. A. Hampel. Reinhold. 715 pages. $22.

Inorganic Chemistry of Qualitative Analysis. By A. F. Clifford. Prentice-Hall. 515 pages. $6.95.

Letters: Pro & Con

Pro: Electroplating Bond

Sir:

Your March 20 Corrosion Forum (pp. 188-192) makes some unfortunate implications which we believe should be refuted. In particular, we refer to the statement that "plating produces a much weaker bond between base metal and coating" than does diffusion.

Our corporation has expended a good deal of research effort along the lines of obtaining bond between electroplates (chromium in particular) and their substrates. As a result, we categorically claim that electroplates may be bonded to almost any substrate with "perfect" adhesion, a bond stronger than the weaker of the two metals involved.

Unfortunate experiences with peeling electroplates arise from the fact that users who normally consult with competent engineers in almost every other field will consult the yellow pages of the local phone directory for electroplating aid.

H. CHESSIN
Van der Horst Corp. of America
Olean, N. Y.

Con: Nitrogen Oxide Fumes

Sir:

Just read your article, "Exhaust Converters To Smother California Smog at Source" (Apr. 3, p. 88).

You are barking up the wrong tree. What are you going to do with the tons of NO_2 put in the air by diesel combustion? When diesel exhaust is deionized, smog is gone.

JOSEPH P. RUTH
Denver, Colo.

► *Mr. Ruth enclosed with his letter additional documents aimed at condemning diesel buses and striking the fear of God into those of us whose offices overlook the heavy crosstown bus traffic shuttling back and forth along New York's 42nd St. Here are excerpts:*

"The silent killer that stalks our streets is ionized anhydrous nitric acid from diesel exhaust. . . . The reason lung cancer is partial to the

American male is that in some cases they must work in buildings above diesel fumes. . . . If California had known that diesel buses would bring toxic, eye-burning smog upon them, surely they would not have permitted the displacement of electric buses with diesels. . . . In cities such as Cincinnati, where they still have substantially all electric coaches, they have no smog. . . . New York is considering putting in 5,000 *diesel taxicabs. The public, however, will pay dearly in the destruction of their health from breathing the anhydrous nitric acid inherent in diesel combustion."*—ED.

Pro: Plant Cost Bases

Sir:

I am very happy to see you publishing cost-capacity data for various chemical plants in your Cost File.

This information would be considerably more valuable if the basis for the plant cost was adequately specified. For example, in the case of methanol (Feb. 20, p. 176), which plant units are included? Those such as synthesis gas generation, conversion and purification, compression, methanol synthesis and product purification? Are off-site facilities included, which would make this a "grass-roots" plant, or is a "battery-limit" facility intended? I note that the chart for oxygen plants (p. 174) does give some consideration to these various factors.

J. KOSLOV
Vitro Engineering Co.
New York, N. Y.

Sir:

This is in response to Mr. Koslov's questions concerning methanol plant costs.

The cost-capacity curve in our presentation includes manufacturing of synthesis gas, compression, conversion and product purification. In other words, this is conventional manufacture of methanol from petroleum gases.

The single curve as shown covers the condition of "new producing

units located within a previously developed plant site." It may have been possible to present methanol figures for "grass-roots" plants or for enlargements of existing units, but we did not feel that the information available to us would support the complete picture.

J. E. HASELBARTH
Pritchard & Abbott
Houston, Tex.

Foreign Headache Remedies

Sir:

Mr. Adams' comments on "foreign business headaches" (Feb. 20, pp. 223-4) are interesting, as they reveal problems that one might have been unaware of.

In addition to competition in and from Europe, there will certainly be growing competition from other quarters. This is inevitable, and largely a natural outcome of a situation that we ourselves helped create. It will be hard to turn the clock back.

However, international financial arrangements are not difficult to make, with proper counsel. At present I see no need for a barter bank or the like, since suitable arrangements can be made through established and convenient channels.

The risk of revolutions is generally remote. When they happen, they rarely come as surprises. The Cuba revolt, for example, had plainly been in the cards for at least a decade.

You can obtain information on the credit standing of any company anywhere if you ask the right people; sources of such information are plentiful.

Insurance of any kind—even the oddest—can be purchased from private companies—at a price, of course. The prospect of more interference of administration bureaucrats seems to me more frightening than any other calamity and should not be conjured up lightly; it may not take much provocation.

Running a business demands, in addition to technical know-how, a knowledge of markets and methods, a flair for intangibles that may or

may not be there, and a sixth sense of a kind that is not usually found in trained scientists and engineers because it has been trained out of them.

MAX F. WULFINGHOFF
Professional Engineer
Erlanger, Ky.

Pro: Plastics Developments

Sir:

Upon opening your Feb. 20 issue I discovered, much to my delight, a sizable story on various papers presented at our annual technical meeting. We were extremely pleased with this article and your recognition of the conference and its outstanding papers.

R. D. FORGER
Society of Plastics Engineers
Stamford, Conn.

Pro: Fluorine in Rocketry

Sir:

Dr. Hendel's article, "Chemical Rocket-Propulsion Systems," in your Mar. 6 issue (pp. 99-114) is excellent.

We believe, however, that recent advances in fluorine technology in rocketry make it no longer necessary to consider that "handling problems and highly toxic exhausts limit fluorine's use in rockets."

We document these views by citation of the papers on fluorine technology presented at the Propellant Thermodynamics and Handling Conference, Columbus, Ohio, July 20-21, 1959; plus a paper presented by A. R. Kimball at the September 1959 Cryogenic Engineering Conference, Berkeley, Calif.

These papers, while representing major advances in fluorine technology over the past several years, do not convey the whole story as of today. More recently, still other remarkable strides have been made, including development of a turbo-pump-fed engine system and ground-handling procedures for rocket servicing.

FRANK HOLLOWAY
Allied Chemical Corp.
New York, N. Y.

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Chemicals

Activated Carbon.....A complete line of activated carbons for every purpose. Complete purification, separation & recovery systems. Further details in Bul. J-104.
L205 *Barneby-Cheney

Beta Resorcylic Acid.....is a formula for a wide range of reactions. A versatile starting material for preparation of commercial organic compounds. Details.
16-17c *American Cyanamid Co.

Chemical Grout.....AM-9 chemical grout changes the earth's consistency. Transforms porous soil into impervious matter. Further information is available.
16-17a *American Cyanamid Co.

Chemicals.....Armoflo compounds are described in a booklet to help in your particular operation. This booklet along with a sample for conditioning are available.
10-11 *Armour Industrial Chemical Co.

Chemicals.....Information and samples are available on Sodium Borohydride in both powder and liquid form and on Lithium Aluminum tri-t-Butoxy Hydride.
85 *Metal Hydrides, Inc.

Chemicals Glossary.....11-page glossary of 483 organic chemicals contains National Aniline's code number and name, the Chemical Abstracts name and trade name.
234A National Aniline Div.

Extender Pigments.....Technical bulletin on research conducted to improve surface properties of extender pigments summarizes years of study; outlines tests and procedures.
234B Minerals & Chemicals Phillipp Corp.

Fluorides.....for catalyst, reagent, intermediate, process applications. Technical information on all the various fluorides is available on request.
65 *Allied Chemical

* From advertisement, this issue

Fused Quartz.....Vitreosil has extreme heat resistance. Available in many types & sizes. Also fabricated to your special needs. Complete, illustrated catalog.
L249 *Thermal American Fused Quartz Co.

Industrial Alcohol.....Guide to bulk storage of specially denatured alcohol and proprietary solvents covers government regulations and suggested tank design.
235A U. S. Industrial Chemicals Co.

Lactonitrile.....is an inexpensive, bifunctional raw material. It is convertible to a host of useful intermediates. A booklet is available for details.
16-17b *American Cyanamid Co.

Morpholine.....Brochure describes chemical used as an intermediate for rubber chemicals, a corrosion inhibitor in boilers and a separating agent for volatile amines.
235B Jefferson Chemical Co., Inc.

Polyethylene.....12-page brochure describes properties and characteristics of a new ethylene plastic polymer that combines durability with processability.
235C Goodrich-Gulf Chemicals, Inc.

Propylene Glycol.....Brochure deals with properties and applications and provides extensive solubility data in convenient tabular form on important low toxic chemical.
235D Jefferson Chemical Co., Inc.

Resin.....8-page brochure describes the chemical and physical properties and potention applications of its SMA resins, a new series of maleic anhydride copolymers.
235E Texas Butadiene & Chemical Corp.

Silicone Defoamers.....Job-proved thousands of times as the most efficient, most economical and most versatile foam suppressors available. Manual is offered.
R241 *Dow Corning Corp.

Silicones.....8-page catalog describes complete line of silicones and their uses, and deals with silicone fluids, protective coatings, electrical insulation and rubber.
235F General Electric Co.

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Solvent.....A new bulletin is available giving properties, specifications, shipping data & uses of Filmex solvent for flexographic inks. Send for your copy.
34a *U. S. Industrial Chemicals

Tetrahydrofurfuryl Alcohol.....As the market for THFA expands and new uses develop, price reductions become possible. A new price schedule is available.
69 *Quaker Oats Company

Toluidine.....Data sheet SD-82 discusses properties, hazards, engineering control, safety precautions, storage practices, tank and equipment cleaning etc. of chemical.
236A Manufacturing Chemists' Assn., Inc.

Construction Materials

Cable.....MI cable is ideally suited for all types of trouble areas. The many unique characteristics of this versatile cable construction in the new MI catalog.
112 *General Cable Corp.

Carbon Brick.....linings provide long service life in tough corrosion applications. For tanks, reactors, drain troughs & sumps. Information in Catalog Section S-6215.
106 *National Carbon Company

Cement.....One-Cote insulating-finishing cement goes on in one coat to the desired thickness. Insulates, protects and finishes. Descriptive materials is available.
42 *Eagle-Picher Company

Coatings.....Technical data are available for information on various coatings such as Dimetcote No. 4, which is self-curing, Dimetcote No. 3 and Amercoat No. 99.
197 *Amercoat Corp.

Coatings & Enamels.....Imlar vinylmastic coatings & vinyl enamels have been developed for use where metal protective finishes are not recommended. Bulletin.
191b *E. I. DuPont de Nemours

Concrete Floors.....Specifications for vermiculite insulating concrete floors on grade, with or without radiant heating covers mixing, curing, preparation and applications.
236B Vermiculite Institute

Copper-Clad Laminated Plastics..... Brochure contains revised standards for copper-clad laminated plastics conforming to the latest issue of military specifications.
236C Synthane Corp.

Diatomite.....Celite assures consistent results and less down-time in every grade. Each grade has its own distinctive particle size distribution. Write for further information.
143 *Johns-Manville

Epoxy Enamels....Corlar epoxy chemical-resistant enamels have been developed for surfaces subject to severe corrosive conditions. Technical bulletin offered.
191a *E. I. Du Pont de Nemours

Filter Fabrics.....The handy information booklet, "Filter Fabric Facts" contains distributors names and answers problems related to your selection of filter fabrics.
98 *Wellington Sears Co.

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Filter Media.....not only for filter presses but for other types of filters as well. Also a wide selection of filter paper. Bulletin 141 offered on request.
R221 *T. Shriver & Co., Inc.

Filter Paper.....custom-tailored to your process & your press. A 24-page catalog on industrial filter papers gives complete details. Catalog 357.
124 *Eaton-Dikeman Co.

Gasket Material.....Booklet describes "Armalon" felts & includes data on characteristics, detailed list of specific applications, & information on sizes & thicknesses.
113 *E. I. Du Pont

High Temperature Laminate.....Data sheet describes Synthane Grade AA-HT, a heat resistant laminate of an asbestos woven fabric bonded with a high temperature resin.
237A Synthane Corp.

Insulation.....Ultralite's glass fiber composition does not rot, corrode, support mildew or vermin or otherwise deteriorate. Complete information and application methods.
213 *Gustin-Bacon Mfg. Co.

Insulation.....Calsilite-Hi insulation is ideal for both insulation and fireproofing. Specifications or samples of Calsilite & Calsilite-Hi insulation are available.
111 *The Rubberoid Co.

Lead Products.....These products include chemical lead sheets to your requirements; pipe, bends, traps & standard fittings. Bul. 162, the Lead Handbook for the CPI.
126 *American Smelting & Refining

Material of Construction.....Rulon is a specially-compounded form of Teflon and other inert ingredients. Bulletin describes shapes, properties & typical fabricated parts.
237B Dixon Corp.

Nickel Alloy.....Data sheet T-1 lists the corrosive media in which Colmonoy nickel alloys are generally resistant and discusses corrosion resistance in general terms.
237C Wall Colmonoy Corp.

Packings.....Asbestos-Teflon packings with low breakaway friction and excellent corrosion resistance. Catalog P-100 for information on packings and gasket materials.
224 *Raybestos-Manhattan, Inc.

Protective Linings.....49-page test chart manual was designed to help steel container users select proper protective linings by telling "which lining holds what for how long".
237D Bradley & Vrooman

Refractories.....to answer your specific needs. Varied unusual refractories to solve unusual problems. Further information is contained in descriptive brochures.
8-9 *Carborundum Co.

Refractory Castable.....Kaocrete-B is excellent for gunning in vertical or overhanging applications with low rebound loss. Bulletin R-35B is available.
117 *Babcock & Wilcox Co.

Rupture Discs.....Model CPV is designed for low pressure application while Model HOV is designed to operate closer to rupture pressure. Catalog is offered.
L241 *Fike Metal Products Corp.

* From advertisement, this issue

LITERATURE . . .

Sizing.....Bulletin T-6C gives physical properties and applications methods of Neo Cryl BT-4 a alkali-soluble acrylic copolymer for textile sizing. Send for your copy.
238A Polyvinyl Chemicals, Inc.

Stainless Steels.....Special stainless steels help cut maintenance expense. Information on special and standard grades of stainless steel is available.
219 *Armco Steel Corp.

Wire Cloth.....Whatever metal or alloy needed in any size or quantities to the closest tolerances. High mesh counts are featured. An illustrated 120 pg. catalog.
54 *The Cambridge Wire Cloth Co.

Electrical & Mechanical

Expansion Joints.....Catalog AD-137 contains information on solid teflon and teflon-lined expansion joints for chemical processing applications.
28 *Garlock Inc.

Gas Engines.....Bulletin discusses two-cycle gas engines with particular emphasis on their performance characteristics in variable-speed, variable load applications.
238B Clark Bros. Co.

Mechanical Seals.....Type U mechanical seals require almost no maintenance. Used in all industries and for all applications. Further information is available.
222 *Borg-Warner

Motors.....Bulletin B-2515 shows and describes complete line of A-C motors from 1 to 2,000 hp. Product features are outlined for easy selection in varying applications.
238C Reliance Electric & Engineering Co.

Power Recovery Turbine.....designed for power recovery from any gas mixture. Further information on any power recovery turbine application is available.
Cov *Worthington Corp.

Protective Relays.....Paper "The Coordination and Testing of Protective Relays in Industrial Plants" outlines system that serves 100 laboratories and plants of du Pont.
238D Multi-Amp Electronic Corp.

Speed Reducers.....with built in product quality and performance. Latest information on these speed reducers is contained in illustrated literature which is offered.
73 *Cleveland Worm & Gear Div.

Starting Motors.....2-page pamphlet describes companies part-winding starting motors. Speed-torque characteristics are plotted as well as connections for part-winding.
238E Century Electric Co.

Steam Turbine-Generator.....Complete information on types and ratings from 2000 kw to the largest is contained in Bulletins 7654A & 9448 which are offered.
14-15 *Allis-Chalmers

Switches.....Visible blade construction of these switches insures safety. Handle designed as an integral part of the switch adds extra safety.
95 *Square D Company

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Unilets.....New CES-CESD type receptacle Unilet & matching plug gives outstanding performance for all industrial equipment. Bull. CES660 is available on request.
1 *Appleton Electric Company

Handling & Packaging

Air & Gas Handling.....Equipment for efficient & economical cleaning and handling of air and gas. Further information on the products of interest.
261 *Aerotec Industries, Inc.

Automatic Scales.....Technical bulletin on how automatic bagging and proportioning scales are promoting good housekeeping, controlling quality, etc.
214 *Richardson Scale Co.

Bucket Elevators.....manual is designed to simplify selection and application of bucket elevator systems for bulk handling of material in powdered, crushed or lump form.
239A Webster Mfg. Co., Inc.

Concrete Tanks.....16-page brochure on circular prestressed concrete tanks contains engineering and construction data on basic tank elements and discusses use of tank.
239B The Preload Co.

Conveyors.....Air-Float conveyors provide trouble-free air-gravity conveying of dry materials. No moving parts, nothing to wear, nothing to maintain. Details.
94b *Kennedy Van Saun

Lift Trucks.....Line of lift trucks in the 2,000 to 10,000-lb. capacity ranges is described in a 16-page catalog that contains power curves and specifications.
239C Allis-Chalmers Mfg. Co.

Lift Trucks.....The flexibility of gas power plus the efficiency of electric drive offered in the GLF series is discussed in a new 16-page booklet "Facts and Factors".
239D Automatic Transportation Co.

Pneumatic Conveying Systems.....All standardized components, capacities & horsepower requirements are shown in Bulletin 228 which is available on request.
220 *Sprout, Waldron & Co., Inc.

Refuse Collection.....Super Dumpmaster no-container-haul system can be used with Dumpster containers. A free brochure gives information on this new system.
96 *Dempster Brothers

Transportation Equipment.....Every unit is engineered to meet service requirements, including complete piping, metering and transfer equipment. Details.
4 *Pressed Steel Tank Co.

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Air Preheaters.....Ljungstrom package air preheaters for use on boilers from 25,000 to 250,000 pounds of steam per hour. Details in 14-page booklet.
48 *The Air Preheater Corp.

* From advertisement, this issue

LITERATURE . . .

Circulation Heaters.....Catalog 60 gives full data & uses for Chromalox electric circulation heaters. They are complete packaged, highly efficient units.
R205 *Edwin L. Wiegand Company

Drying & Cooling System.....Louisville fluidized bed equipment for use as dryers, coolers and reactors. Further information is contained in Bulletin FBD-61.
185 *General American Transportation

Film Type Exchangers.....are used as Coolers, Condensers, Absorbers, Heaters, & Evaporators. Bul. HE-8 describes unusual & standard heat transfer equipment.
144 *Henry Vogt Machine Co.

Heat Exchanger.....Aero heat exchanger is a closed system of cooling, free from dirt. Bulletins 120 and 132 are available for complete information.
B262 *Niagara Blower Company

Heat Exchanger.....Selection of the right titanium heat exchanger is a sure-fire way of controlling your costs. Performance data & fabrication are offered.
122 *Titanium Metals Corp. of America

Heat Exchangers.....Bulletin discusses features of two exchangers with straight tubes, externally packed floating tube sheets, removable bundles and single two-pass design.
240A American-Standard

Heat Exchangers.....24-page catalog describes new line of shell and tube heat exchangers using standardized components. Complete engineering data is included.
240B The Griscom-Russell Co.

Heat Exchangers.....to solve many problems of cooling under intense pressures for many types of chemical, petroleum and petrochemical applications. Bulletins offered.
244 *The Vilter Mfg. Co

Heat Transfer Cement.....Thermon can be applied over both steam tracing & electrical resistance systems & is effective for heating & cooling operations. Bul. 300.
R240 *Thermon Mfg. Co.

Heaters, Direct-Fired.....“Q” Pak packaged direct-fired heaters need no refractory lining even at temperatures of 3,000F. Safe for use in fire hazardous areas.
83 *Black, Sivalls & Bryson

Liquid Phase Heater.....The Vapor Modulatic Hi-R-Temp phase heater is a forced circulation, coiled tube, direct-fired heater of two-pass design. Bul. No. 4023.
125 *Vapor Heating Corp.

Temperature Controls.....A handy, condensed catalog of the complete line of temperature controls & allied equipment for industrial heating & refrigeration.
105 *The Partlow Corp.

Instruments & Controls

Analyzers.....Brochure discusses basic principles of nuclear magnetic resonance analysis that covers product quality control, process control and research uses.
240C Ridgefield Instrument Group.

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LITERATURE . . .

Analyzers.....A wide range of instrumentation covers the entire control loop. Measuring elements, transmitters, recorders, alarms, etc. installed as an integrated system.
22-23 *Foxboro Company

Cascade System.....in one recorder case. Bulletin 98286 contains details on the single case cascade idea pioneered in the Transcope Recorder.
108 *Taylor Instruments Companies

Comparator.....Handbook, "Modern pH & Chlorine Control" gives theory and application of pH control. Illustrates and describes full line. Available on request.
R204 *W. A. Taylor & Co.

Computer, Gas Flow.....New gas flow computer eliminates accounting losses in custody transfer of gases. Measures, records and totalizes mass rate of gas flow.
199 *Minneapolis-Honeywell

Control Systems.....Provide maximum automation for data acquisition, transmission, recording and control of process variables. Technical Bulletin 10 available on request.
47 *Robertshaw-Fulton Controls Co.

Controller.....Series 532 pneumatic recording controller is outstandingly simple, reliable and stable. Designed for batch-type & continuous processes. Data.
128 *The Bristol Co.

Controls.....Trimount proximity controls give precise level measurement. Feature complete automatic level control of a wide range of materials. Booklet is available.
241A General Controls Co.

Controls.....for measuring and regulating all the variables that enter into process control. Further information on the complete line is available on request.
39 *Hagan Chemicals & Controls, Inc.

Data Computer.....Series 3100 Dataplotter offers compact, single-cabinet design with plotting speeds up to 80 points per minute. Specific details offered.
228a *Electronic Associates, Inc.

Data Logger.....Data-Master modular design makes data logging easy, economical and outstandingly versatile. Complete information is available on request.
210 *The Bristol Company

Flowmeters.....A new series of turbine flowmeters for totalizing, recording, blending, telemetering and measurement applications is described in bulletin 1384B-2.
241B Cox Instruments Div.

Gauges.....The unique Maxisafe Duragauge provides absolute protection to the viewer plus easy & quick access to the mechanism. Catalog 300B.
30 *Manning, Maxwell & Moore

Gauges.....Specification sheets describe features and technical characteristics of nuclear density measuring gauges for processing applications using up to 3" pipes.
241C The Ohmart Corp.

Liquid Level Controls....Floatless Electrode type are unaffected by acids or caustics. Standard 2 & 3 pole units listed by U/L. Complete specifications in 32-pg. Catalog.
BL263 *Charles F. Warrick Co.

* From advertisement, this issue

LITERATURE . . .

Meters.....Varea-Meters feature a wide capacity selection. Transmitters, magnetic indicators & the usual accessories are available. Further information is offered.
216 *Wallace & Tiernan, Inc.

On-Stream Analyses.....Brochure describes operation and application of an instrument that conducts continuous on-stream analyses of critical constituents in water.
242A Hagan Chemicals & Controls, Inc.

Pneumatic Instrumentation....Bulletin explains how drive speeds of machines and processes can be automatically controlled and regulated by pneumatic instrumentation.
242B Reliance Electric & Engineering Co.

Pneumatic Transmitter.....The 273 offers the widest differential pressure ranges, the highest safe working pressures & widest variety of housing materials. Data.
27 *Barton Instrument Corp.

Process Control Computers.....Analog process control computers can be used for metal refining & forming, chemical processing, petroleum refining, etc. Information.
228b *Electronic Associates, Inc.

Spectrophotometer.....Bulletin 735-B describes recorder used in quality-control studies, molecular structure analyses and numerous other research applications.
242C Beckman Instruments Div.

Speed Measurement Systems.....Bulletin GEZ-3251 describes line of a-c and d-c tachometer generators and indicators. Includes specifications, calibration, schematics, etc.
242D General Electric Co.

Voltage Digitizers.....Data sheet describes highly accurate, high-speed, all semiconductor, analog voltage input to digital output convertors with great sensitivity.
242E Adage, Inc.

Voltmeter.....The new, single-package V60 Digital Millivoltmeter is a full 4 digit instrument that averages 80 measurements per minute. Further information.
101 *Non Linear Systems, Inc.

Pipes, Fittings & Valves

Ball Valves.....Double-Seal ball valves are available in wide variety of materials and sizes for many applications. Literature is offered on request.
109 *Jamesbury Corp.

Ball Valves.....Comprehensive information on manually operated and pneumatically operated ball valves in sizes from ¼" through 12" is given in catalog 1200.
242F Hills-McCanna Co.

Connectors & Couplings.....A new line of set screw Thinwall connectors & couplings has been introduced. Further information is contained in Bulletin TWT-161-1.
242G Appleton Electric Co.

Control Valves.....Model 1900 self-draining control valve has many applications in the process industries. Latest technical information is available.
187 *The Annin Company

* From advertisement, this issue

Control Valves.....Catalog B-1 is available for complete data on these versatile valves for positive control of your problem fluids. Send for your copy.
BR264 *G. W. Dahl Co.

Control Valves.....Flo-Ball control valves are made in wide range of sizes from carbon steel, 316 stainless steel and other materials on request. Complete information.
89 *Hydromatics, Inc.

Control Valves.....Bulletin shows dimensional drawing, sizing charts, flow curve, and complete engineering specifications of control valves of cast steel and stainless steel.
243A OPW-Jordan

Fittings.....made to A.S.A. & M.S.S. standards. Feature square end, circularity & true wall uniformity & machine tool cut bevel. Form I-92 is offered.
81 *Flowline Corp.

Heat Exchanger Tube.....Trufin type S/T tube helps shrink plant costs & boost production. A copy of Trufin Comparison Costs Book is available on request.
99-100 *Wolverine Tube Div., Calumet & Hecla

Liquid Level Gage Valves.....4-page data sheet illustrates and describes features, styles, sizes and construction details of liquid level gage valves.
243B Jerguson Gage & Valve Co.

Nozzles & Connectors.....to answer your connection problems. Imaginative engineering, customized design & skilled workmanship. Catalog available.
TL221 *Lenape Hyd. Press. & Forg. Co.

Pipe.....safely handles 94% of known corrosive solutions. It is lightweight and no painting or maintenance is necessary. Further details are available.
35 *Fibercast Company

Pipe.....Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information.
116 *Saran Lined Pipe Co.

Pipe & Fittings.....A complete service including welding fittings, shop fabricated piping & erection service. A 20-page bulletin, "Critical Piping for the Nuclear Age."
121 *Midwest Piping Co.

Pipe, Pyrex.....comes in all standard sizes and fittings. You can see through the pipe wall into the flow area. Further information in Bulletin PE-3.
130 *Corning Glass Works

Swivel Joints.....US type are designed exclusively for the chemical industry. Can be welded into the line and can be repaired on location with simple tools. Catalog.
45 *Continental-Emsco Company

Tubing, Heat Exchanger.....offers high quality at lower cost. Information on welded steel and stainless steel heat exchanger tubing is contained in Brochure No. 5.
63 *The Standard Tube Co.

Valve.....The plug seals securely in a Teflon sleeve. Priced to replace ball valves, gate valves & lubricated plug valves. Bul. V/14 is available on request.
195 *Duriron Co.

* From advertisement, this issue

LITERATURE . . .

Valves.....Bulletins are available on rubber-lined iron body gate valves in rising stem, cylinder, & motor operated types as well as on iron body check valves.
40 *Darling Valve & Mfg. Co.

Valves.....Forged steel valves are available on all lines up to 2 in. Designed to meet control requirements with minimum replacement & maintenance. Information.
131 *Ohio Injector Co.

Valves.....Two methods for determining flow characteristics of Rockwell-Nordstrom valves are described in a revised bulletin that contains charts and graphs.
244A Rockwell Manufacturing Co.

Valves & Actuators.....The mix & match versatility of these valves & actuators lets you select the degree of performance you desire. "Valve Size Computer" offered.
6-7 *Minneapolis-Honeywell

Valves, Ball.....in a full range of pipe sizes from ⅜″ to 14″. A wide range of design variations including metal castings of stainless steel, carbon steel, etc.
142 *Rockwood Sprinkler Co.

Valves, Line Blind.....Hamer line blind valves offer fast, easy positive line blinding. The new Hamer Valve Catalog 60 is available on your request.
245 *Well Equip. Mfg. Corp.

Valves, Solenoid.....Complete information on all models available. Also a 16-page brochure which lists over 500 corrosive media . . . coded for correct valve selection.
L204 *Valcor Engineering Corp.

Valves, Stainless Steel.....All the features of these stainless steel valves are covered in the Stainless Steel Catalog No. 59SS which is available on request.
79 *Jenkins Bros.

Venturi Tube Accessories.....4-page bulletin describes accessories to insure high accuracy standards and freedom from maintenance by preventing flow disturbances.
244B B-I-F Industries

Process Equipment

Air Separators.....offer precise separation and improve screening. Increase 40 to 400 mesh output as much as 300%. For further information Bul. 087 is offered.
R248 *Sturtevant Mill Co.

Mills, Ball.....are noted for high tonnage & low cost processing of phosphate rock & other agricultural chemicals. Further details are now available.
94a *Kennedy Van Saun

Centrifuges..... Fletcher-Matic centrifuges are practically self-operating. Tornado-Matic and Suspend-O-Matic models are described in Bulletin 202-560.
181 *The Sharples Corp.

Classifier.....Article explains how classifier uses only air flow to fine from coarse material. Graph shows particle size distribution of original and aggregate.
244C Buell Engineering Co.

* From advertisement, this issue

Cyclone Collector.....New collector tube and inlet vane designs in this cyclone collector result in sharply increased operating efficiency. Information.
258 *John Wood Company

Drying Equipment.....New catalog No. 201 contains detailed descriptions of the complete line of Drying Equipment. It is available on request.
260 *J. P. Devine Mfg. Co.

Drying Equipment.....Kathabar equipment for toasting, drying or cooling. Complete data is available on request for further information on these systems.
234 *Surface Combustion

Dust Control.....An extensive line of cyclones, scrubbers, and filters to solve a wide variety of dust recovery problems. Details are contained in Bulletin A-9150.
24 *The Ducon Co.

Filters.....Multi-Bag filters in a wide range of standard sizes permits engineering to meet almost any dry collection requirement. Information on these & other units.
110 *Dracco Div. of Fuller Co.

Filter Press.....can be equipped with any type of plates—made of virtually any material—to handle any filterable mixture—and most filter media. Sperry Catalog offered.
49 *D. R. Sperry & Co.

Filters.....have highest flow rates with minimum pressure drop and complete chemical resistance. Details are contained in Bulletin FPT-2 which is available.
L248 *Chem Flow Corp.

Filters.....Micro-Filters for fine filtration operations. All the facts about Micro-Filters are contained in Bulletin MF-1 which is available on request.
R259 *Selas Flotronics, Selas Corp.

Floats, Stainless Steel..... New booklet includes construction data, application information, shape specifications, weight tables, buoyancy formulas, etc.
TR249 *Chicago Float Works

Fluid Mixer.....Bulletin describes a lifting-lowering mixer designed for operations where a stationary impeller does not produce a satisfactory mixing result.
245A Philadelphia Gear Corp.

Horizontal Filter.....Type 122 Horizontal filter is described in detail in Bulletin 122. Engineered systems for your requirements through controlled filtration.
87 *Industrial Filter & Pump Mfg. Co.

Inert Gas Generators.....stand up under the toughest conditions, yet produce with complete dependability. Complete information in Bulletin I-10.
177 *The C. M. Kemp Mfg. Co.

Laboratory Homogenizer.....Minimum sample one pint; capacity 15 GPH; pressures up to 8000 PSI. Additional information is contained in Bulletin LH-55.
L240a *Manton Gaulin Mfg. Co., Inc.

Lubricator.....forces oil of any viscosity against the high steam, gas and air pressure so common in modern compressors, engines & machines. Catalog is available.
236 *Manzel

* From advertisement, this issue

LITERATURE . . .

Mill.....The two-stage design of the RE Colloid Mill provides continuous micrometer control for producing superior emulsions or dispersions. Bul. C-57.
L240b *Manton Gaulin Mfg. Co., Inc.

Mills.....Complete information on "Jet-O-Mizer" Mills, "Jet-O-Clone" Dust Collectors, and testing and custom grinding services is now available on request.
200 *Fluid Energy Processing & Equip.

Mixer, Portable.....for fluid mixing, in sizes from ⅛ to 3 hp, gear drive or direct drive. A descriptive Bulletin B-520 is available on request. Send for your copy.
266a *Mixing Equipment Co., Inc.

Mixers.....Mix-Muller saves valuable raw materials and in many cases eliminates secondary processing. Details on a laboratory conducted survey & Handbook on Mulling.
141 *National Engineering Co.

Mixers.....A full line of Flomix, side drive, tank top, portable and tripod mixers are available. Additional information on all types in Bulletin 531A.
193 *Nettco Corp.

Mixers.....Dispersator mixers with the patented "Micro-Shear" head feature: double shearing, balanced operation at much higher speeds than conventional mixers, etc.
BL259 *Premier Mill Corp.

Mixers, Mounted.....Bulletin B-521 describes permanently-mounted Lightnin mixers for open & closed tanks. Sizes from ¼ to 3 hp. are available.
266b *Mixing Equipment Co.

Molecular Sieves.....offer important savings achieved by increasing throughput of existing equipment. Designed for low-maintenance cyclic processing. Details.
223 *Linde Co., Div. of Union Carbide

Molecular Vacuum Stills.....Operating costs of high vacuum stills are less than 1/10¢ per pound because of lowered heat input, higher yield. Bulletin 3-1.
247 *Consolidated Vacuum Corp.

Plastics Processing System.....All the well known advantages of continuous processing have been adapted to compounding polyolefins and other plastics.
41 *Baker Perkins Inc.

Process Equipment.....Catalog "A" discusses pressing, drying and cooling equipment and will give help in solving your particular problem.
BL229 *Davenport Machine & Foundry Co.

Process Equipment.....Mixing, cooking or cooling equipment plus vacuum pans, coils, coating pans, filters, tubular heat exchangers, etc. are covered in Engineering Manual.
R263 *Groen Mfg. Co.

Process Equipment.....such as dryers, coolers, combination ammoniator-granulators, furnaces, cookers, reactors, presses and pilot plants. Literature is offered.
230 *Edw. Renneburg & Sons

Processing Equipment.....A 32-page report on impervious graphite processing equipment covers 16 different types of equipment. Includes sizes, dimensions & costs.
119 *Falls Industries, Inc.

* From advertisement, this issue

Processor.....A complete 24-page bulletin presents the story of the design, application and operation of the Turba-Film Processor. Bulletin 117.
71 *Rodney Hunt Machine Co.

Purifiers.....Hi-eF purifiers can be relied upon to give outstanding performance. Bulletin 804 contains specifications on standard type plus engineered units.
TR264 *The V. D. Anderson Company

Scrubber.....Joy Microdyne scrubber does the job so efficiently in so little space. Steel & corrosion resistant alloy construction. Literature is offered.
BL221 *Western Precipitation

Solids-Processor.....adds vacuum drying to liquid-solids blending. Systems completely packaged. In standardized models with charge capacities from 1 to 50 cu. ft.
60-61 *Patterson Kelly

Spray Nozzles.....Catalog 24 contains 48 pages of reference data on thousands of spray nozzle designs and sizes. Choice of capacities, characteristics & materials.
TL259 *Spraying Systems Co.

Pumps, Fans & Compressors

Acid Pumps.....in 1" to 8" discharge sizes with 10 to 3000 GPM capacities, heads to 200' and higher. Pumping parts are available in a variety of alloys and plastic.
265 *A. R. Wilfley & Sons

Centrifugal Pump.....Series 1510-B centrifugal pump is now available in "C" size units up to 75 hp. Price and Selection Catalog is available on request.
25 *Bell & Gossett Co.

Compressors.....A wide variety of designs of compressors in sizes up to 5,000 horsepower and for pressures up to 15,000 psig. Motor or steam drive. Information.
20-21 *Chicago Pneumatic Tool Co.

Compressors, Dynamic.....in sizes from 15 to 15,000 hp. Complete performance profile for every compressor manufactured. Information in Bulletin 2563-11.
29 *Joy Manufacturing Co.

Compressor, Piston.....assures absolute contamination-free compression of dry or moist gases. Unique ringless piston & frictionless piston rod. Information & specifications.
TL229 *Sulzer Bros., Inc.

Fan.....New Twinalator offers unique superior dual function air handling for all types of buildings. Further information is contained in Bulletin 552.
26 *Clarage Fan Co.

Fan.....New design duct fan by De Bothezat has a removable cone design. Descriptive literature on this new type of fan is available on request.
237 *American Machine & Metals, Inc.

Fans.....Centriline fans take up less than half the space of conventional centrifugal fans. A catalog on the new space-saving Centriline fans is offered.
207 *Sturtevant Div., Westinghouse

* From advertisement, this issue

LITERATURE . . .

Metering Pump.....Pulsafeeder metering pump offers precision metering at flow rates of from a few drops to 15.7 gal. per minute. Complete details in Catalog 59.
211 *Lapp Insulator Co.

Midget-Centrifugal Pumps.....Your guide to a broad line of midget-centrifugal pumps and stirrers for the laboratory is Bul. 400 which is available.
55c *Eastern Industries, Inc.

Pressure Blowers.....Type CB pressure blowers for a wide variety of applications. Capacities to 37,500 cfm & pressure to 74" w.g. Details in Bulletin FI-310.
43 *Buffalo Forge Company

Pump.....Horizontal Jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc. Information in Bulletin 212-1.
201 *Lawrence Pumps, Inc.

Pump.....Series 100 pump features accurate metering with smooth control plus double capacity or two-liquid metering. Further information is available.
217 *Wallace & Tiernan, Inc.

Pump, Controlled Capacity.....for continuous, accurate metering of all types of liquids. Available in both diaphragm & plunger type construction. Information.
31 *Frederic B. Stevens, Inc.

Pump, Hydrostatic Test.....designed for pressure testing of high pressure components. Especially useful for testing valves, fittings & gauges. Catalog.
246 *McCartney Mfg. Co.

Pumps.....for hard-to-handle liquids in the chemical industry. Pumps range from 25 to 2500 hp., pressures to 50,000 psi. Additional information is available.
46 *Aldrich Pump Company

Pumps.....Acid pumps, centrifugal and gear types, protected by Ace Hard Rubber are described in Bulletin CE-55 which is available on request.
132 *American Hard Rubber Co.

Pumps.....Every pump is tested before it leaves the plant. The whole line of pumps is cataloged in Bulletin One which is available on request.
T262 *Blackmer Pump Co.

Pumps.....Turbine Pot pumps offer true pumping economy and versatility. They are compact and ruggedly built for longer life & continuous, trouble-free operation.
77 *Fairbanks, Morse & Co.

Pumps.....Model 3195 pumps simplify process engineering and cut parts inventories. They offer maximum interchangeability. Bulletin is available on request.
107 *Gould Pumps, Inc.

Pumps, Centrifugal....New catalog 130 describes 50 different models. Offer pressures: to 21 psi. in single stage pumps; to 70 psi. in multi-stage types.
55a *Eastern Industries Inc.

Pumps, Displacement.....with flow rates from ½ gpm to 5½ gpm, pressures from 30 to 200 psi. High pressure outputs with small, low power units. Bul. 220.
55b *Eastern Industries, Inc.

* From advertisement, this issue

LITERATURE . . .

Screw Pumps.....maintain high volumetric efficiency because of "Dual-Controlled" precision rotor design. Available in both horizontal or vertical construction.
238 *Sier-Bath Gear & Pump Co.

Services & Miscellaneous

Bleaching Process.....Technical bulletin describes new continuous bleaching process that cuts manufacturing costs up to 40 per cent on natural and synthetic fibers.
249A Olin Mathieson Chemical Corp.

Cleaning Service.....offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. Information offered.
179 *Dow Industrial Service

Fire Fighters.....High pressure fog and its effectiveness in fighting fires is featured in a 16-page catalog that lists specifications for all types of fire fighting equipment.
249B John Bean Div.

Fire Protection.....A 16mm. sound-color film demonstrating all types of fire hazards and how to guard against them may be borrowed on your request.
120 *Grinnell Company

Flames Arrester Vents.....prevent flash-backs into tanks, process kettles, etc. through vent opening. Details in Vent Catalog which is available on request.
R229 *The Protectoseal Co.

Laboratory Ware.....44-page catalog describes, illustrates and gives prices on hundreds of items of plastic laboratory ware for science and industry.
249C Bel-Art Products

Lubrication System..... Complete details on Alemite Accumite Centralized lubrication system for large or small, stationary & mobile equipment in Alemite Accumite Catalog.
37 *Stewart-Warner Corp.

Maintenance Cleaning....Sixteen fact-filled pages in a new booklet spell out the latest procedures for chemical cleaning of chemical soils. Bulletin No. F-10822.
235 *Oakite Products, Inc.

Printed Weight Records.....New Print weigh "400" prints complete weight records on tickets or sheets, also on strips. Time & data printing available. Bulletin 2017.
242 *Toledo Scale Corp.

Safety Equipment..... The new Red Book contains flammables engineering fundamentals and complete line of safety containers and operating equipment.
R229a *The Protectoseal Co.

Switch Lockouts....Safety Guide SG-8 describes recommended safety precautions in electrical switch lockouts for equipment and controls on circuits up to 600 volts.
249D Manufacturing Chemists Assn. Inc.

Water Coils.....Type R removable-header water coils feature complete drainability, high heat transfer & easy cleaning. Details are contained in Bulletin R-50.
226 *Aerofin Corp.

* From advertisement, this issue

Employment Opportunities

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

SENIOR

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Responsible Growth Position with

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Salary plus bonus.
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2—Sharples C-20 and C-27 Super-D-Hydrator, 316 S.S.
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2—Bird 24" x 38" Solid Bowl Continuous 304 S.S.
1—Bird 36" x 50", Solid Bowl, Continuous, 347 S.S.
1—Bird 40" x 60" Solid bowl continuous, 316 SS, unused.
3—Sharples PY14, PN14 Super-D-Canters 316 S.S.
2—Fletcher 48" Suspended 316 S.S. Perforated Basket.
2—Sharples #16, 304 S.S., 3 HP motor.

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1—10,000 gal. rubber lined Tank 10' x 17'6".
2—2700 gal. 316 SS Vertical Agitated Tanks with Coils.
1—4200 gal. 316 SS Vertical Tank, 8' x 12'.
1—5500 gal. 316 SS Clad Pressure Tank, 250 psi.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
4—Stainless Heat Exchangers; 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Col.

FILTERS

1—#5 Sweetland Filter 304 S.S. 120 sq. ft.
1—Oliver 6' dia. Horizontal Filter, 316 S.S.
1—Oliver 4' dia. Monel Horizontal Filter.
1—Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaportite housing.
1—Feinc 3' x 1' 316 SS Rotary Vacuum Filter.
1—Feinc 5' x 6' Stainless Steel Rotary Vacuum Filter.
2—#12 Sweetland Filters, 36 leaves, 4" centers, 500 sq. ft.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

DRYERS

1—Buflovak Vacuum Shelf with 17—60" x 80" shelves.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Buflovak 32" x 90" Atmos. Twin Drum.
2—Devine 4' x 9' single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Stokes 4' x 20', 304 SS Rotary Vacuum.
6—Louisville Rotary Steam Tube 5' x 25', 6' x 30', 6' x 50'.
2—Louisville 8' x 50' Stainless Steel lined Rotary Dryers.
9—Rotary Dryers 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
1—Louisville 4½' x 25' Inconel Rotary.
2—Link Belt, 7'5" x 25', 6'4" x 24", S.S. Louvre Dryers.
1—Stokes model 38-A Tray Dryer with 16—36" x 36" S.S. Shelves.
2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
1—P&S 6' wide Apron Conveyor Dryer 48' long.
2—10' and 4' dia. 304 S.S. Spray Dryers.
2—Wyssmont Dryers, 304 S.S. 6'2" and 9'6" dia.

MIXERS

1—Abbe 110 gal. 304 S.S. Jacketed Agitated Vacuum Dispersall Mixer.
2—Day Imperial 150 gal. jktd. double arm.
2—Baker Perkins 150 and 100 gal. jacketed double arm Sigma blades.
1—Baker Perkins 50 gal. jacketed, double-arm.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—Patterson 6' dia. Conical Blender 15 HP.
1—3' dia. Simpson Intensive Mixer.
1—2' dia. Simpson Intensive Mixer 304 S.S.
1—45' dia. Lancaster Mixer 7½ Hp motor.
1—Patterson Kelly 150 cu. ft. Twin Shell Blender.
1—Patterson 80 cu. ft. Conical Blender, 304 SS.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 1000 cfm, 10 microns, 15 HP.
1—Thropp 6' x 12" 2 Roll Mill, 7½ HP motor.
2—Hardinge 5' x 22" steel lined conical Ball Mills.
3—Mikro Pulverizers, 1SH, 1SI and Bantam.
3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.
1—Raymond 10" vert. Mill, 10 HP.
1—No. 1 Bail & Jewell Rotary Cutter.
1—#18 Cumberland Rotary Cutter.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
2—#842 Rotex Sifters 60" x 84" double deck.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
3—Nash H6 Vacuum Pumps.
4—Stokes Rotary Tablet Machines DD2-DD52-DS3-RB2.

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PROFIT SAVERS

5—#12 SWEETLAND FILTERS In Stock

72 leaves on 2" centers complete with hydraulic closing. Motor driven sluicing devices and special deep bottoms. Very excellent condition.

Priced Low For Quick Sale

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CIRCLE D ON READER SERVICE CARD

FOR SALE
Double ROLL CRUSHER
1—24" x 20" Jeffery Double roll crusher—New 1955, with 15 H.P. motor and new spare parts.
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LAfayette 4-1471

CIRCLE E ON READER SERVICE CARD

FILTER PRESSES—6" load P&F w/pump, 18x18 (26 chamber), 30x30 (11 chamber)

MILLS—Hardinge Conical, 3'x8", 3'x24", 5'x22", 8'x36", 8'x48", 6'x12' rod w/200 HP

VACUUM PUMPS—115 CFM Beach Russ RP w/5 HP motors, Leiman 105 CFM, Dorr Oliver 200 CFM-piston

DRYERS—ROTARY—24"x22', 3'x24', 4'x40' 5'x50', 7'x58', all w/motor drives.

MIXERS—New 3 qt. sigma/jacketed, 5 gal. Bramley 5 HP vac./jack., 12 gal. sigma, 22 cu. ft. ribbon blender.

E. W. LAWLER has stopped piloting International Jet Liners—Full time super service now for YOU.

MIKRO BANTAM w/vari feed drive, 4TH Mikro (unused) w/Mikro collector & 3x5 Tyler screens for closed circuit.

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9 Gen. Elec. 20, 25, 45, 65, 70, 80, 100, 125 Ton
25-Ton Industrial Brownhoist 60' Boom Crane
200—50 Ton Box, 300—70 Ton Gondola Cars

PLANT EQUIPMENT
4' Traylor TY Gyratory Crusher
2—Wemco 2M-HMS Plants
36" x 96" H. R. Vibrating Pan Feeder. NEW
No. 1 Startevant Rotary Fine Reduction Crusher
F55 Syntron Grizzley Feeder
5' x 8' & 4½' x 9' KVS Air Swept Ball Tube Mills
Ball Mills: No. 56, 5' x 5', 6' x 4' x 9' & 7' x 22'
Hardinge Mills: 3' x 8', 3' x 24" & 5' x 22"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8" x 10", 10" x 20", 14" x 28", 18" x 36", 30" x 36", 48" x 60", 48" x 72", 66" x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½' & 7'
436 Allis Chal Hydrocone 75 H.P. Motor
Crushers, Roll: 24" x 14", 30" x 14", 40" x 16"
Rotary Dryers: 3' x 30', 5' x 30', 6' x 50', 6' x 70' & 8' x 80'
Rotary Kilns: 36"x30', 6'x70', 7'x120' & 9'x160'
2—42" x 120" Buflovak Atmos. Double Drum Dryer
Roto Louvre #207-10 Type 316 SS, Link Belt
150—1½, 2 & 4 yd & 30 yd Dump Cars
7'x120' Allis Chalmers Rotary Kiln ⅝" welded shell
Laboratory Rotary Kiln, 36" x 30". Complete
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2—6' x 12' Allis Chalmers 2 Deck Vibrating Screens
16' Gayco Centrifugal Air Separator
BX-100 Sutton Steele & Steele Air Table NEW
6—30" x 32" Dings Magnetic Head Pulleys
650', 2200', 3065' & 3600-7500' IR. Compressors
4100 CFM Sly Dust Collector

WANT BUY DRYERS—KILNS—CRUSHERS
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TRY IT BEFORE YOU BUY IT

GOOD USED MACHINERY ON APPROVAL

1—Allis Chalmers Stainless Lined 6' x 50' Rotary Dryer. ½" shell
2—Sharples H 1½ Stainless Steel Nozzle Jectors. 7½ HP motors
16—New Am. Heat Reclaiming Spiral Heat Exchangers, 55 & 120 sq ft
1—Raymond 5 roller Hi Side Mill. Model 5057. Raymond 6' dbl Whizzer Separator. Kemp Inert Gas unit

1—Cedar Rapids 30 x 33 Slugger type Hammermill. With 150 HP motor
1—Rubber Mill, 15¾" dia x 28" long Farrel Birmingham. 76 HP Motor
1—Strainer 8½" National Erie Gear red. and 125 HP motor
1—Gayco 4' dia Whizzer Mechanical Air Separator. Model 38

MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

CIRCLE N ON READER SERVICE CARD

Day Hy—R Speed Mill 20 HP Expl. Pr.
Buffalo 32"x90" Double Drum Dryer.
Centrifugals: 12", 30", 40" & 48".
Amer. Tool 18" Stainless Centrifugal.
Centrifuges: Sharples #5 & #6 Stainless.
Dryers: Hersey 5'x26' Rotary, 316 Stainless.
Buffalo Vac. Drum Dryer, 24"x20".
Despatch Ovens Elec. Heated & others.
3—Devine & Stokes Vac. Shelf Dryers.
Filters: #2 Sweetland 12 Stainless Leaves.
Oliver Rot. Vac. 3'x1'.
Hercules Leaf Filter 36" dia.
Filter Presses: 6" to 36" Iron & Wood.
Kettles Tanks: S.S. Jack 20 to 500 gal.
Dopp 350 gal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" & 36" dia.
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Mikro Pulverizers #4, 2, 1, & Bantam.
Hammer Mills & Pulverizers 3 to 50 HP.
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Rotary Cutters 1½ to 5 HP. & up.
Spr. Waldron Stainless spike crusher.
Pebble, Jar & Ball Mills, Lab. to 6' x 8'.
3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12' x 36" Steel.
Colloid Mills 1½ H.P. & up.
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Dopp 1000; 1700 gal. Reactors jkt., agit.
435 Sq. ft. Single Effect Evaporator
Goslin Birm. 36"x24" Rotary Vac. Filter
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14"x18' Packed, 10 PSI
12"x18' Packed, 100 PSI

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4500 gal. 6'x25' dish/cone heads, 25 PSI
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4000 gal. 7'6"x14' dished heads
3500 gal. 8'x9' dished heads
1500 gal. 6'x6'9" dished heads
750 gal. 5'x5' plain and agitated
500 gal. 4'x5' plain and agitated
400 gal. 4'x4' plain and agitated
300, 250, 150, & 100 gal.

MISCELLANEOUS

Pfaudler 500 gal. ELL Glass Lined Reactor
Buflovak Vacuum drum Dryer 6"x8" drums
Buflovak 6' Vacuum Crystallizers
Nash Hytor Vacuum Pumps #9, #4
Copper Tanks 3500 gal. to 200 gal.
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Write for detailed catalogue

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Two Marions, model 490E, with 2½ yd. Ansco dippers, 29 foot booms. All GE 2400 volt equipment. With a large amount of spare parts. Priced extremely low.

P & H model #1400—D E shovel. With 5 cu. yd. dipper, 32 ft. boom. Cooper-Bessemer Diesel, Nordberg Diesel light plant. Operating unit with large stock of parts Built 1950.

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1 Browning. Model M1. 50 foot boom. Caterpillar D-17000 engine. 8 wheel mechanical drive.

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- Wrappers
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- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

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CIRCLE U ON READER SERVICE CARD

SPECIALS

Kettles: 69 Lee 40 gal. stain. clad, 40# WP,
Kettles: Stainless: other makes and sizes.
Column: 24" x 22', 316 stain. steel.
Pebble Mills: Abbe #3, #6 and others.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
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Filter: Sweetland #5 st. st. lined.
Filter: Eimco, drum 18" x 12".
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Proctor & Schwartz 6-tray st. st.
Centrifugal: AT & M 60" st. st. perf.

Write us or call Seeley 8-1431
Send us a list of your idle machines

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Screener 2 Deck S.S., also steel

S.S. Jacketed—Blender—Double Ribbon —240 cu. ft.—total

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Aluminum Evaporator Calandria type—never used—1300 sq ft. tube area

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Pfaudler 30 gal. Model T. Reactor Complete
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No better values at any price

85 CFM (Actual) 3500 PSI Clark HO-6-4C
110 CFM 3000 PSI Ing. GC 50BW
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MAY SPECIALS

Abbe 5'x6' Jktd. Ball Mill, chrome mang. steel
Gruendler #3 Hammermill, whirlbeater, 22"
Simpson 24" Lab. Mix Muller, 1½ HP motor
Patterson-Kelly Twin Blender SS 5 cu. ft. 3 HP
Read SS Jktd. 6 qt. Lab Mixer, vac. cover 1½ HP
Day 75 gal. sigma arm Mixer with 7½ hp motor
2 Oliver Rotary Vac. Filters, 3'x2', 63"x8'
Pfaudler 1500 gal. glass Lined Tank closed top
Ribbon Blenders, Steel & SS, all sizes, New & Used

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GELB

CHEMICAL PROCESS EQUIPMENT

1—Struthers Wells SS single effect evaporator, 1100 sq. ft. —NEW
2—Process Engr. SS 10,000 gal. storage tanks—NEW
2—600 gal. SS jacketed autoclaves, complete with agitators and drives, 150 psi jacket
1—Titan SS Super Ejector

THE GELB GIRL—MAY 1961

AUTOCLAVES, KETTLES, REACTORS

1—Pfaudler Series P, 30 gal. glass lined jacketed reactor, complete with agitator and drive
1—Pfaudler Series EL 750 gal. glass lined reactor, jacketed
2—Pfaudler Series EM 300 gal. glass lined jacketed reactors
1—Blaw Knox 300 gal. SS vacuum reactor
2—Blaw Knox 600 gal. steel autoclaves
2—Blaw Knox 200 gal. nickel jacketed autoclaves, 175 psi jacket and internal
2—Theo. Walters Hastelloy B 300 gal. jacketed reactors
1—Van Alst 300 gal. SS jacketed kettle
1—Alloy Fabricators 600 gal. jacketed autoclave, 135 psi internal, 135 psi jacket

CENTRIFUGES

1—Sharples type 316 SS centrifuge, Model DD-2
1—Western States 40" type 316 SS suspended type centrifuge
1—Fletcher 48" SS underdriven centrifuge, complete
5—Tolhurst 40" and 30" rubber covered centrifuges
1—AT&M 26" type 316 SS suspended type centrifuge, complete
1—AT&M 48" SS suspended type centrifuge, complete

DRYERS

2—Stokes single door vacuum shelf dryers, 6 and 8 shelves
2—Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
1—Link Belt Steel Roto Louvre Dryer, Model 207-10
2—Bonnot rotary kilns, 8' x 115', complete
1—Bonnot rotary cooler, 8' x 50', complete
1—Allis Chalmers SS rotary dryer, 6' x 50', complete
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
2—Stainless steel pilot plant spray dryers
2—Buflovak SS rotary vacuum dryers, 5' x 30'
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20', 5' x 35'
1—Hersey rotary dryer, 3' x 20', complete
1—American 42" x 120" double drum dryer, ASME, complete

FILTERS

1—Hercules SS filter, 60 sq. ft.
1—Niagara SS filter, Model 510-28
12—Sweetland #12 filters with 72 SS leaves
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
10—Shriver plate and frame filter presses, 12" x 42"
1—Oliver horizontal filter, 3'

MIXERS

1—Baker Perkins SS double arm sigma blade jacketed mixer, 9 gal.
1—Baker Perkins, Size 16, Type UUEM, 150 gal. jacketed double arm, dispersion type mixer, complete with compression cover and 100 HP motor
1—J. H. Day SS 200 gal. double arm sigma blade jacketed mixer
1—J. H. Day SS 5 gal. double arm sigma blade mixer
1—Sturtevant #7 SS dustite rotary batch blender—NEW
1—Banbury #1 mixer with 30 HP motor
1—Stokes SS granulating mixer, Model 21-J
1—Colton SS granulator, Model 561-S
1—Robinson type 304 SS horizontal double ribbon blender, 125 cu. ft.
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.

MISCELLANEOUS

1—Cleaver Brooks 150 HP package steam generator, 150 psi
1—Cleaver Brooks 500 HP package steam generator, 200#
1—Superior 300 HP package steam generator, 125 psi
1—Sprout Waldron pelletizer, Type 501 FF
1—Williams "Comet" 4 roll mill, complete
1—Raymond 2 roll high side mill
1—Ross 6" x 14" 3 roll paint mill, high speed, complete
1—Vulcan stainless steel bubble cap column, 4' x 25 plates
1—Badger type 316 SS bubble cap column, 36" dia. x 8 trays
3—Badger SS heat exchangers, 500 sq. ft. and 600 sq. ft.
1—Griscom Russell SS heat exchanger, 900 sq. ft.
1—Downington SS heat exchanger, 750 sq. ft.
4—Patterson SS condensers, 200 and 300 sq. ft.
2—Davis Engineering Carpenter 20 heat exchangers, 120 sq. ft.
20—Davis Engineering SS heat exchangers, 102, 119, 136, 166 sq. ft.—NEW
2—Mikro Bantam pulverizers
2—Mikro #3TH SS pulverizers, complete
3—Pfaudler glass lined thimble type condensers, 9 and 14 sq. ft.

2—Pfaudler Series R 5000 gal. glass lined jacketed reactors, complete with agitators and drives—NEW
1—Link Belt Steel Roto Louvre Dryer, Model 502-20
1—Sharples SS Super-D-Canter, Model PN-14
1—Oliver SS rotary vacuum filter, 3' x 4'

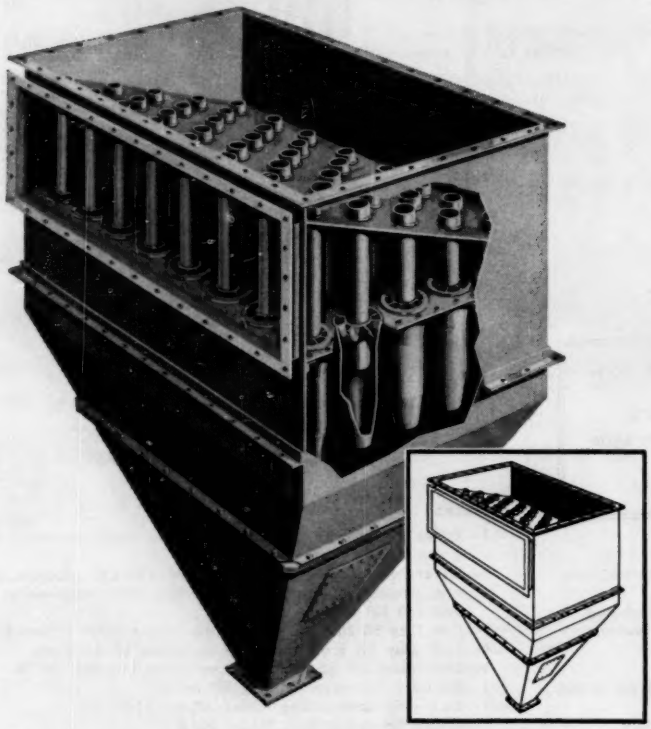
R. GELB & SONS, INC.

U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900

75 ANNIVERSARY

CIRCLE X ON READER SERVICE CARD

New Ideas On Dust And Fume Control



New Products:

John Wood Improved Cyclone Collector

New collector tube and inlet vane designs in the John Wood Cyclone Collector result in sharply increased operating efficiency. These improvements enable the John Wood engineered equipment to provide the uniform gas flow to each cyclone and to assure the high centrifugal force necessary to remove even the smallest particle sizes.

All steel construction and 9" diameter cast tubes and vanes mean high resistance to high temperatures and severe abrasion. A full range of special casting materials meets even the most severe requirements. John Wood Cyclone Collectors are compactly designed and simple to install. Several duct connections and a wide variety of tube arrangements are available to handle gas volumes up to several hundred thousand CFM.

New Engineering: The complete line of John Wood equipment also includes Flooded-Bed Scrubbers, Venturi Scrubbers, Involute Cyclones, Fabric Filters and combination units. Extensive John Wood laboratories are available for advanced research on your air pollution problems.

New Service: John Wood Air Pollution Control is fully programmed from analysis of existing conditions to equipment installation. Frequently economies result that make the installation self-liquidating through lower maintenance and replacement costs.

Write for engineering assistance or specific product information. An air pollution preliminary analysis kit is available without obligation.

AIR POLLUTION CONTROL DIVISION
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NEW-PRODUCT DEVELOPMENT VITAL TO INDUSTRY

Industrial "fairy tales" are few and far between, but here's one with more than a grain of truth. The situation, as you will recognize, has been duplicated frequently, and industry consequently suffers the waste of millions of dollars, as well as an equal amount of man hours and energy, annually — while such stories come true.

Before embarking on the short tale, however, it must be acknowledged that in today's highly accelerated economy, most companies cannot survive without new products or services for their various "publics." At this very moment, in all phases of industry, there are declining products. There are manpower and production facilities that must be utilized more profitably. *And it is to the engineers of today that industry looks for the new products and services of the future.* The road to successful new-product development, however, has many hazards, pitfalls and limitations, and insists on a realistic appraisal and appreciation of *all* the phases of development. Perhaps the following "tale" is an oversimplification, but it will serve at least to introduce the subject for closer inspection.

Once upon a time, a sharp young man named Eddie Engineer had a whopper of an idea. He thought to himself: "If I can design this Widgit, I'll bet lots of people would be glad to pay $1 for it." That very day, he went to his drafting board and started designing his Widgit. After an infinite number of calculations and endless days, he finished his design.

But, Eddie Engineer was a *thinker*, not a *maker*, so he had to find someone to manufacture the Widgit. He found the best manufacturer in his locality, a man of good reputation named Freddie Fabricator. He showed Freddie his plans and convinced him that people would easily pay $1 for a Widgit. Freddie wanted to join in the enterprise, but he had to admit, "I suppose they would pay $1 for it, but it will cost at least $2 to make one of these Widgits, even on a volume basis."

So, poor, dejected Eddie had learned an expensive lesson, because all of his time and effort had gone for naught. If his time had been dollars, he'd have been broke.

Not long after, he had another whopper of an idea, this time for a Gidgit. Before he sharpened a pencil, he went over to see Freddie. Freddie could make the Gidgit and they thought people would pay $2 for one.

FOOTNOTE: For the climax to this tale — and for its possible significance to your professional advancement, write for your complimentary copy of "New Product Development", Booklet E-11, to: Western Supply Company, Heat Exchanger Division, P. O. Box 1888, Tulsa, Okla. — where product development keeps pace with progress in the petroleum and petro-chemical industries.

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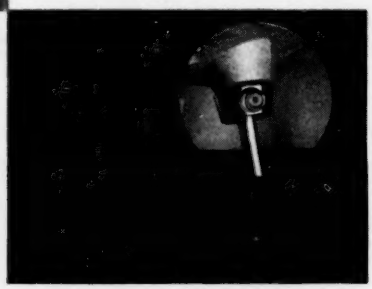

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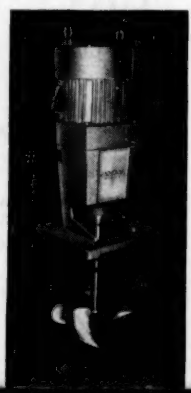

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